465. Skeleton of an American Crow. Art © by Terry Shortt 08s

ANATOMY

11

These precise working parts [bones] of once animate things were so whole in themselves that they left no evidence of the final breakdown of flesh and feather. They were suspended somewhere between being and non being like the documentation of an important event and their presence somehow justified the absence of all that had gone before.

– Jane Urquhart 1983 [u06].

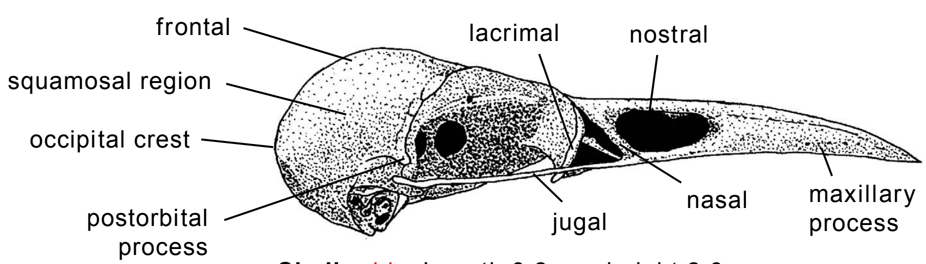
Skeleton

Mr. Terry Shortt, in the book, *Ontario Birds* (1951), did the superb drawing of a standing skeleton (**Art 465**) of the American Crow [08s]. Therefore, I decide to present skeletal images undressed and undone. The photographs, photograms and drawings are more in touch with the words of Jane Urquhart. My ink drawings and photographs are recent and based on one crow skeleton borrowed from the Manitoba Museum in **Winnipeg**. All bones were measured tip to tip. A selection and partial written and visual depiction of some bones of the American Crow follows, starting with the head –

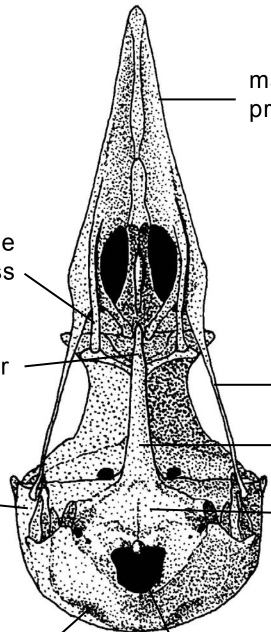
Skull

From the Essex **Ontario** roost, measurements of 20 skulls of American Crows dug from the woodlot floor in the 1980s were –

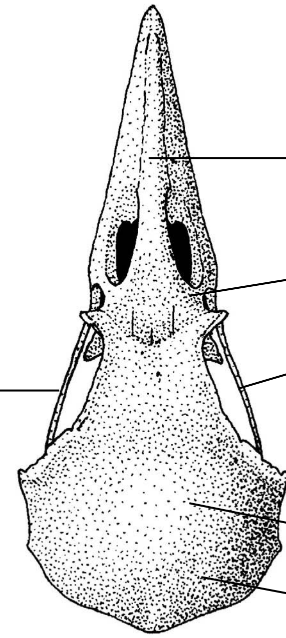
Length 8.6 (8–9.1) cm
Average weight 2.8 grams



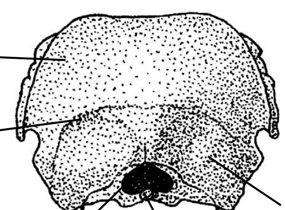
Skull, *side*. Length 8.2 cm; height 2.6 cm



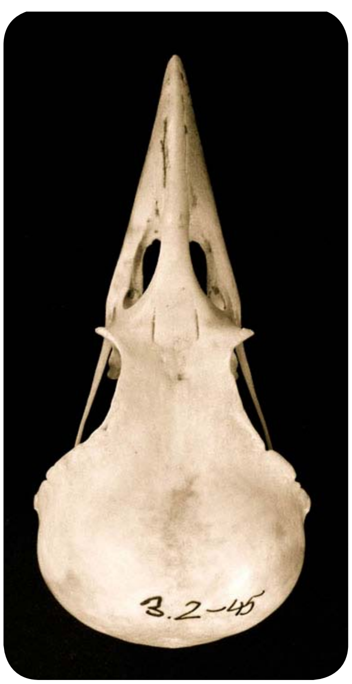
Skull, *below*. Length 8.2 cm; width 3.5 cm; weight 2.4 grams



Skull, *above*. Length 8.2 cm; width 3.5 cm

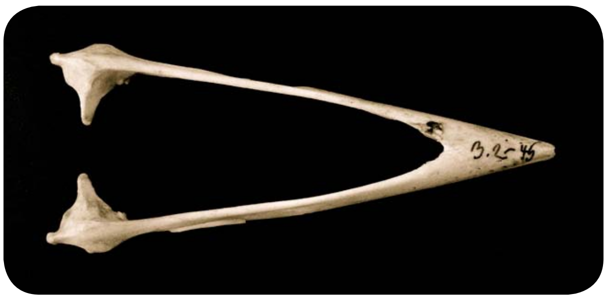


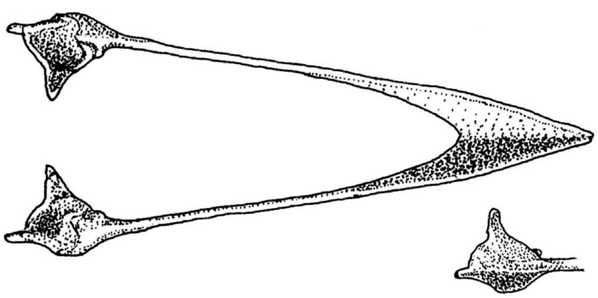
Skull, *rear*. Width 3.5 cm; height 2.6



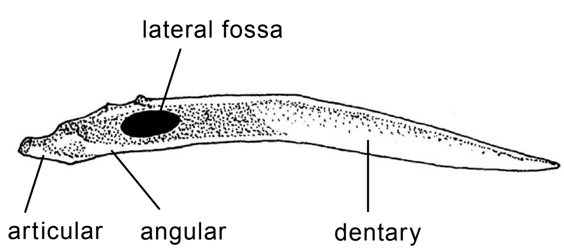
Crow, spring, icy pond

Lower bill. Length 6.5 cm by 2.7 cm wide by 7 mm deep





From one skull at the Manitoba Museum –



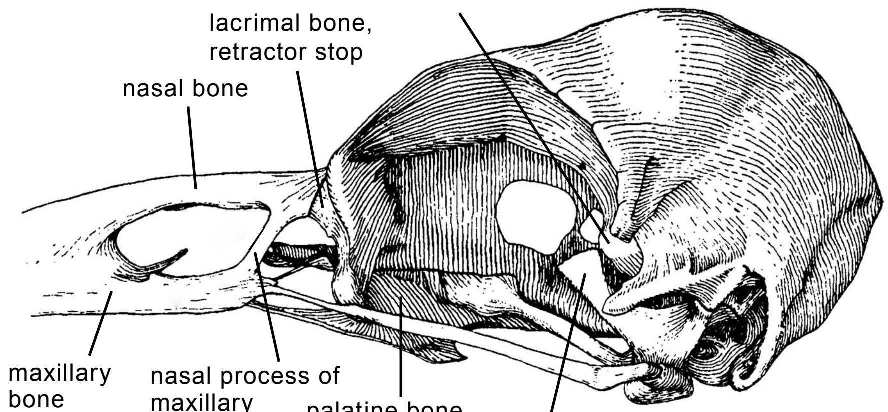
Lower bill, *side*. Length 6.5 cm; depth 7 mm across fossa; weight 0.8 grams (n 1)

Length 8.2 cm	Weight 2.4 grams
Width 3.5 cm	Depth 2.7 cm

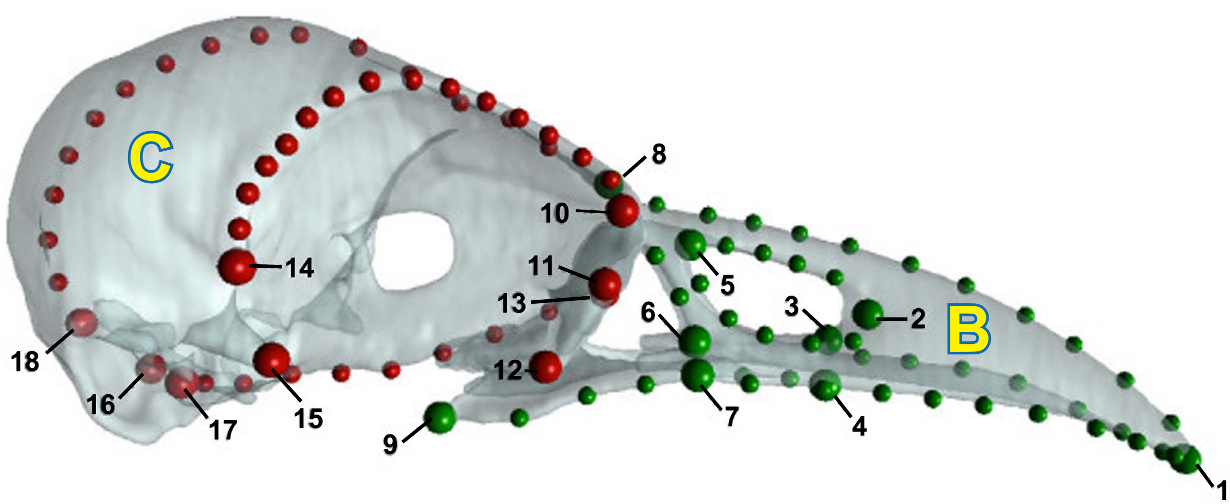
Bills keep growing. When measuring a skull's length, seasonal changes in bill length are not taken into account due to the usual lack of data on time of death, age, sex and other background information on bill wear and size for each American Crow [d20]. A survey of 174 museum specimens was concerned with the growth relationships of the foramen magnum area to body weight and brain volume. For one American Crow, the brain volume was 9 cm^3 and the area of the foramen magnum was 23.7 mm^2. For the mostly non-Passeriformes birds, the "positive correlation between the foramen magnum area and the brain size was found to hold even after the effect of the body size is removed. It means that higher encephalized birds possess a relatively more massive medulla than less encephalized ones" [33m].

Was there a relationship between 115 skulls of 6, unsexed, adult European corvids and their lifestyles? Several assumptions on the related feeding and seeing behaviors were involved. Nevertheless, the 6 corvids exhibited marked

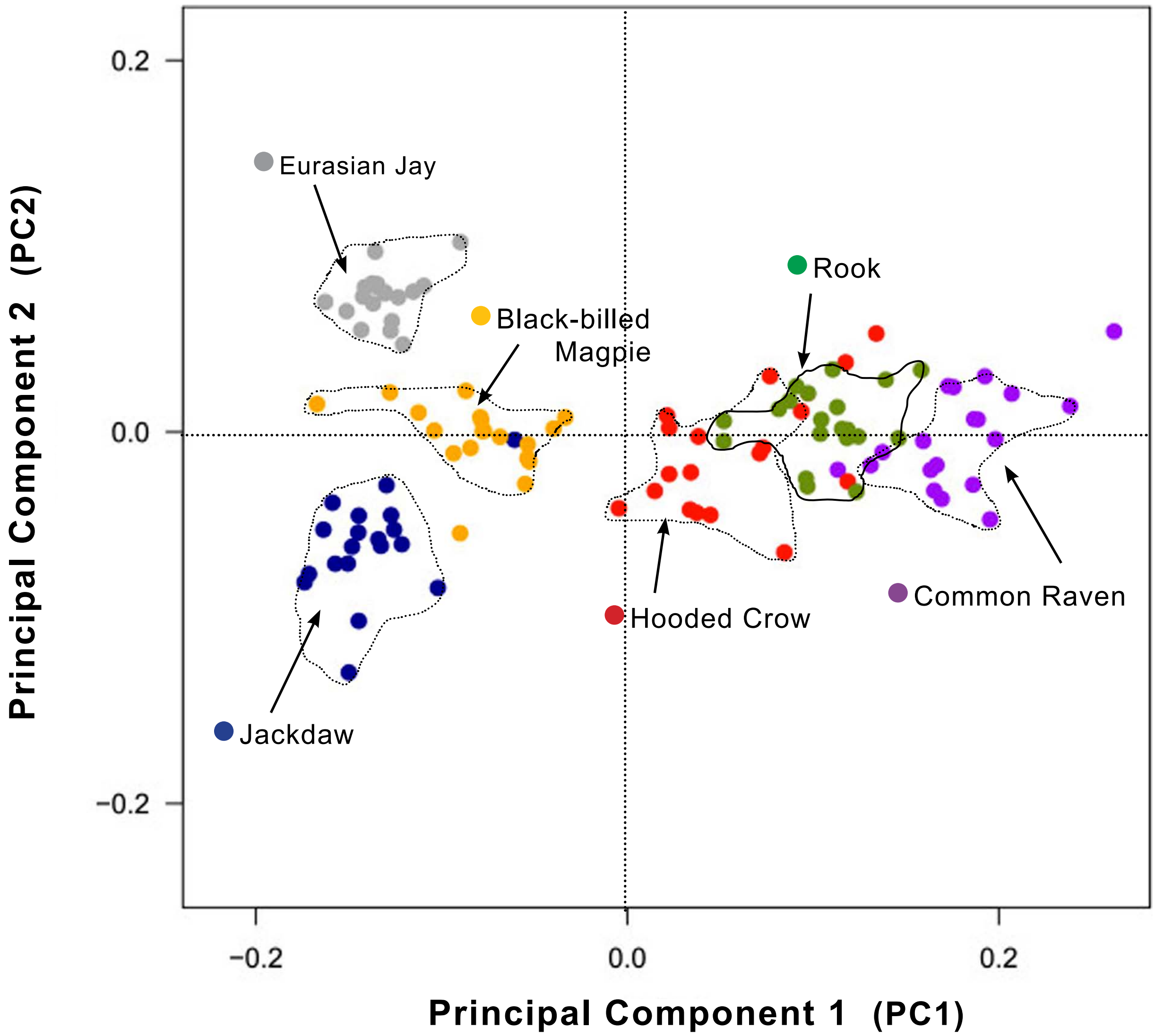
Four crows feeding



469. Skull of the American Crow, *lateral* f33, © The Wilson Ornithological Society, with permission



469a. Corvid **skull**, *lateral*, with landmarks (18 numbered big dots) and semi-landmarks (smaller dots) divided into two areas: **B** = bill (green dots) and **C** = cranium (red dots) 20k, © Frontiers in Zoology, with permission, (see graph 470)



470. The six European corvid species were separated by shape landmark coordinates of their skulls (**Art 469a**). The ● Hooded Crow and the ● Rook had the most overlap 20k, © Frontiers in Zoology, with permission. The 6 outlines are not in the original graph

differences in skull shape, which varied with their foraging mode.

Computed tomography was used to provide cross-sections of the skulls and these were analyzed to compare major variations using principal component analysis (PCA). The bill and cranium were treated separately. PC1 explained 74% of the total variation while PC2 explained 10%. Corvids peck, probe and turn things over as they search for food. Bill shape and size are important in how a particular species feeds. Unfortunately, we don't know how much of the tip of their bill they can see when eating.

The morphology of the skull varied according to the feeding habits of a species. Increasing bill length, curvature, and the sideways orientation of the eyes were associated with an increase in the frequency in probing for food. A decrease in these characteristics was true for corvids that mostly pecked for their food 20k.

Lower jaw

From the Essex **Ontario** roost, 20 recovered lower jaws –

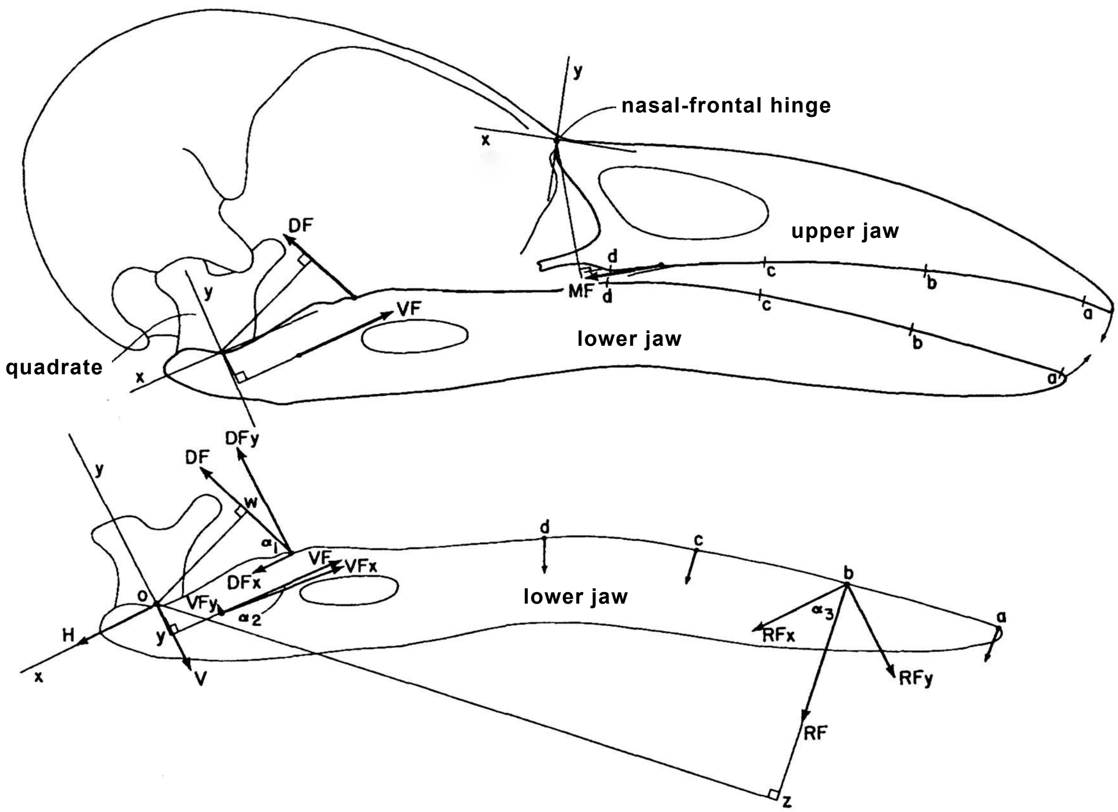
Length 7 (6.3–8) cm   Average weight 1 gram

From one lower jaw at the Manitoba Museum –

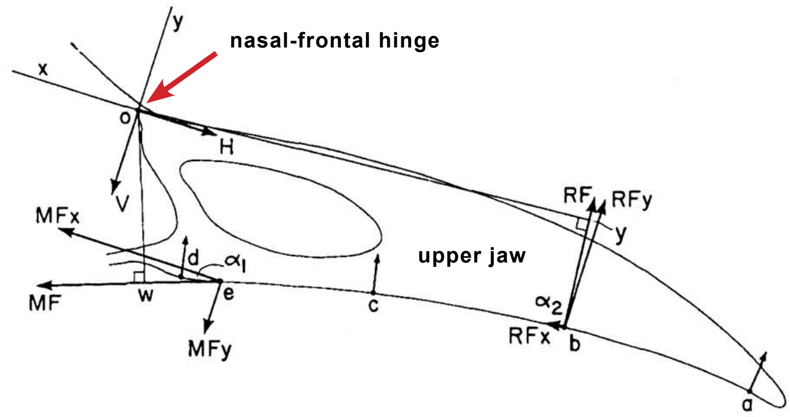
Length 6.5 cm   Weight 0.8 grams
Outside width 2.7 cm   Inside width 6 mm
Depth across fossa (hole) 7 mm
Side fossa 7 mm long by 2.5 mm wide

Jaws

Regarding the kinetics in the jaws of the American Crow, there is a bony stop that restricts the dorsoventral motion (protraction or extension) of the upper bill. “The orbital process of the quadrate has an enlarged, clapper-like end which presses against a papilla in the posteroventral part of the



471. Skull of a crow, *lateral.* **(Upper)** – “The x and y axes pass through the centers of rotation of the jaws. These axes are so oriented that one axis is along the longitudinal axis of the nasal-frontal hinge or of the quadrate. The moment arms of the vectors of the muscle forces (MF, DF, and VF) are the perpendiculars from the center of rotation to the force vector. The points, a, b, c, and d, along the tomium [cutting edge] of each jaw, are the sites at which will be placed the resultant forces acting on the jaws.” **(Lower)** – “The **lower jaw** of a crow isolated from the drawing above. It shows the arrangement of all external forces acting on it when the bird is biting on an object held at point b. Force vectors DF and VF represent the force of the dorsal and the ventral sets of adductor muscles of the mandible; their moment arms are **ow** and **oy**. Force vector RF represents the resultant force exerted by the object on the mandible; its moment arm is **oz**. The H and V forces along the x–y axes at the quadrate are the forces exerted by the quadrate on the mandible; they are the forces equal and opposite to the stresses exserted by the lower jaw on the quadrate-mandibular hinge. The resultant forces acting at points, a, c, and d are also shown” 31b, © American Ornithologists’ Union

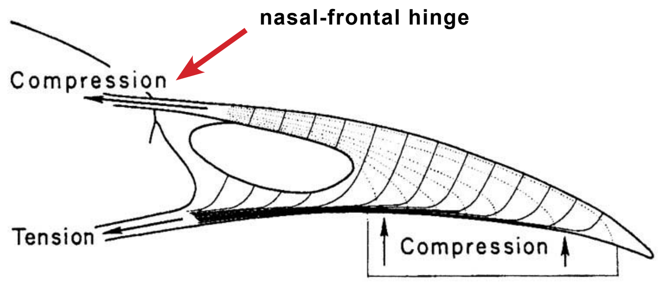


$$\text{Torque} = (MF)(ow) - (RF)(oy) = 0$$

$$\Sigma Fx = -MF\cos\alpha_1 - RF\cos\alpha_2 + H = 0$$

$$\Sigma Fy = -MF\sin\alpha_1 + RF\sin\alpha_2 - V = 0$$

472a. “The **upper jaw** of a crow showing the arrangement of all external forces acting upon it when the bird is biting on an object held at point b. Force vector MF represents the retractor force of *M. pterygoideus*; its moment arm is **ow**. Force vector RF represents the resultant force exerted by the object on the upper jaw; its moment arm is **oy**. The H and V forces along the x-y axes at the nasal-frontal hinge are the forces exerted by the brain case on the upper jaw; they are the forces equal and opposite to the stresses exerted by the upper jaw on this hinge. The formulae for static rotational equilibrium are given. The resultant forces at points a, c, and d are also shown” 31b, © American Ornithologists’ Union



472. “The **upper jaw** of a crow showing the arrangement of trajectories within the jaw when the bird closes its bill against an object. The solid lines represent the trajectories of tension and the dotted lines represent the trajectories of compression. The illustrated pattern of trajectories is schematic and serves only to give an impression of the arrangement of the trajectories within the upper jaw” 31b, © American Ornithologists’ Union

orbit when protraction (dorsal movement of the upper bill) is greatest.”

Protraction (extension) of the upper maxillary in living crows may be stopped by muscles, ligaments, or connective tissue before the final stop comes from the bony structure. The degree of movement of the nasal-frontal hinge in 17 crows was –

(1) Fresh heads 17 (14–19) degrees
(2) Museum skulls* 21 (12–29) degrees

* soaked for 30 minutes in water at 82 ºF

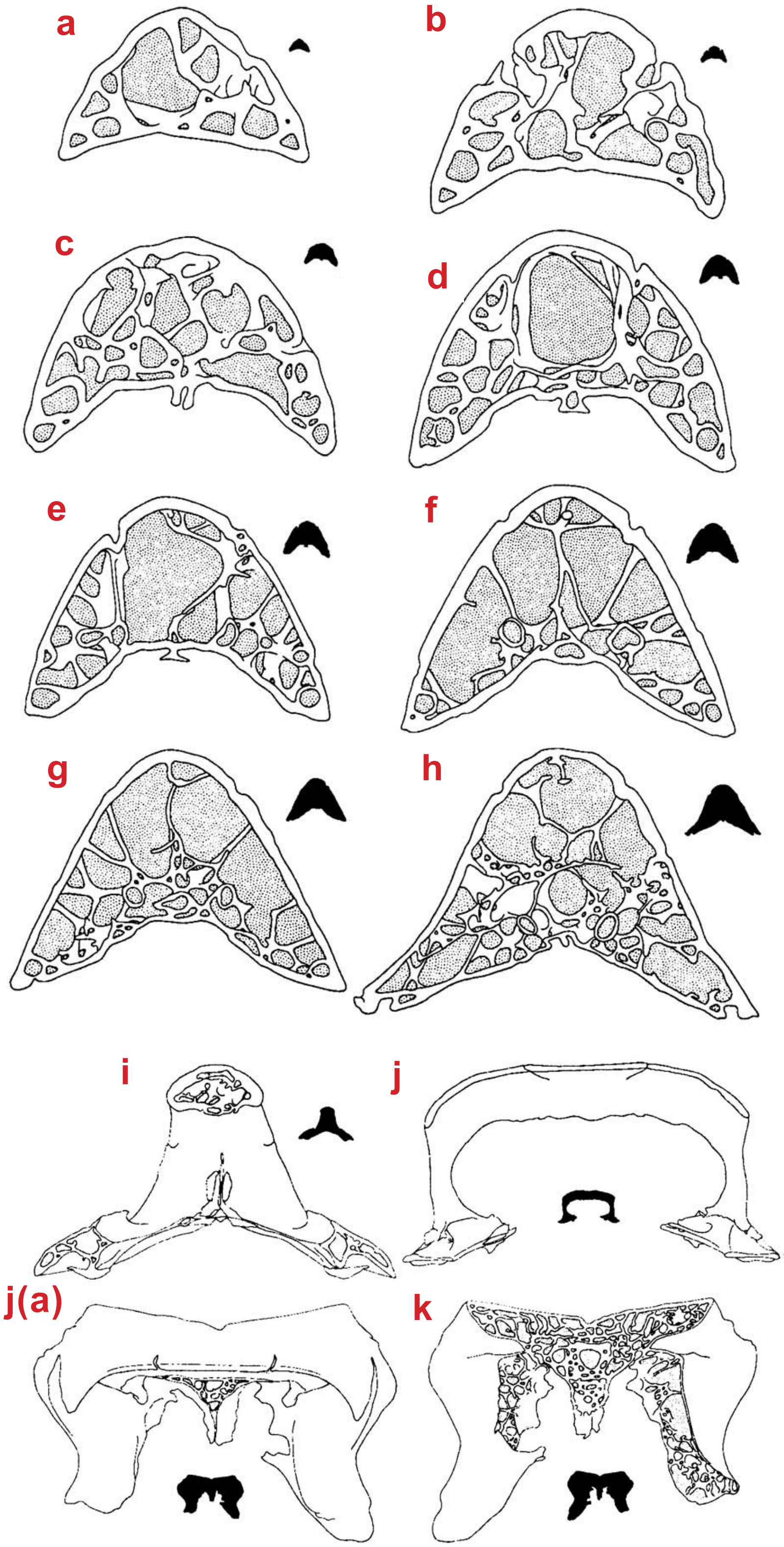
With all the muscles, ligaments, and connective tissue removed on museum skulls, they were not practical in determining the amount of movement for the bill of a living bird. Dozens of fresh heads should have their bill movement measured within 8 hours after dying.

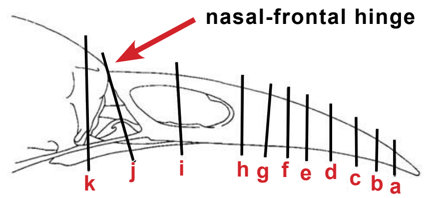
In the American Crow, “the nasal process comes to rest partly on the anterodorsal corner of the lacrimal but primarily on the dorsal end of a much inflated bone closely applied to the anterior surface of the lacrimal.” In museum skulls there is also a greater degree of flexibility in the juvenile bones due to lesser ossification f33.

In the jaw of birds, only the upper bill moves. The lower bill does not move up and down. With the help of ink illustrations (**472 & 472a**) of the crow’s bill by Frances Miller, Bock 31b concentrated on –

(1) forces acting on the bill
(2) necessary size of the bill
(3) weight of the bill

Bock’s lengthy paper on the skull of the American Crow, plus a few other birds, was replete with physical and engineering terms I found somewhat

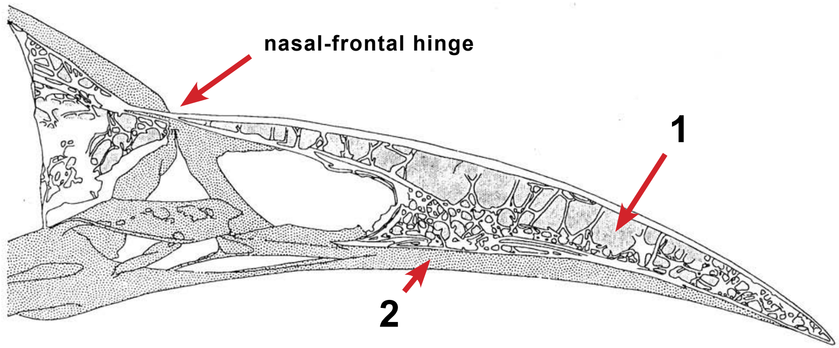




473. The **upper bill** of a crow showing the position of the transverse cuts to the left 31b, © American Ornithologists' Union

473a. "Transverse sections of a crow's skull, showing the trabeculae of the **upper jaw**. Each view is of the posterior face of the jaw at each cut shown in figure 473 above, except view **j(a)**, opposite, which shows the anterior face of the bone at this cut. The jaw was cut as close as possible to the true transverse plane; the angle of cut **j** makes little difference because only the dorsal part of the section is pertinent. The small silhouettes give the absolute size of each section. Note that the trabeculae tend to be less concentrated in the center of the section. The thinness of the bone at the nasal-frontal hinge is shown clearly in sections **j** and **j(a)**" 31b, © American Ornithologists' Union

Bill of an American Crow and nictitating membrane over eye



474. "A *mid-sagittal* section of a crow's skull showing the arrangement of trabeculae within the upper jaw. The deeper, non-trabecular areas of the jaw are **(1)** finely stippled (light gray areas), and the other bone is shown **(2)** in larger stippling. The bone of the dorsal surface narrows to a thin sheet of compact bone at the nasal-frontal hinge" 31b, © American Ornithologists' Union

poetic and rhythmic. For example, "torque analysis allows determination of the external forces acting on the bill, including the stresses on the nasal-frontal hinge and on the quadrate. Trajectory analysis allows investigation of the distribution of forces within the bill and how the bone is arranged best to withstand these stresses. It is suggested that the curvature of the dorsal surface of the upper jaw corresponds to the lines of trajectory. Distribution of stress to the base of the brain case may also have an important part in the shock absorbing function of the kinetic mechanism." The drawings on **page 472** give you an idea of how his analysis developed.

The crow is known as a generalist in its feeding habits. The upper jaw (bill) is connected to the rigid brain case (cranium) at the nasal-frontal hinge (kinetic hinge). This hinge is the pivot for movement in the upper jaw. To allow the upper bill to rise (open), this hinge is a thin flexible sheet of bone. In a cleaned, well-dried crow's skull, this hinge broke at a tensile strength between 35–40 pounds. The break was clean along the entire hinge. The rest of the upper jaw is rather rigid with very little bending from normal use. When holding a seed, the force from the muscle M pterygloideus is transferred through the bony palate of the upper jaw of the crow. Like any large bone in a bird, the upper jaw has an internal network of bony trabeculae (**Figures 473a & 474**) 31b.

Sternum, *side* – Length 5.5 cm; width 3.5; depth 3 cm; weight 1.2 grams (n 6)

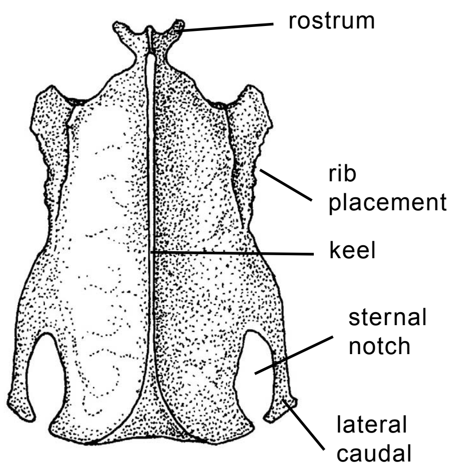
Sternum, *below* – Length 5.5 cm; width 3.5 cm

The pectoral girdle **is made of 4 bones: sternum, furcula, coracoid, scapula** 05p

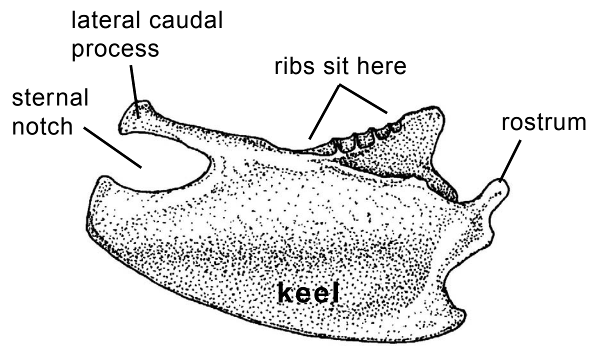
The **sternum** of the American Crow is very thin with some parts semitransparent. The keel (carina) is 0.8 mm thick near its apex. The sternal notch is about 1.2 cm long by 8 mm at its widest. The lateral caudal process is also less than 1 mm thick. Where the 5 ribs are attached, the cavities range from 2–3 mm wide, the widest at the rear. Large flight muscles (breasts) are attached to the sternum. The **furcula** is V-shaped and results from the joining of two clavicles in front of the sternum. The free ends unite with the coracoids. The two **coracoids** act like pillars with their wide bases attached on the front sides of the top of the sternum. The sword-like ends of the two **scapulae** point backwards with the thick ends attached to the top of the coracoids (**Figure 496**). Together, the four bones of the pectoral girdle weighed about 2.2 grams.

I start awake at the cry
Of a bird—my dream is gone.

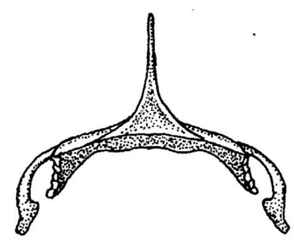
– Chu Shu Chen r47



Sternum, *below* – Length 5.5 cm; width 3.5 cm

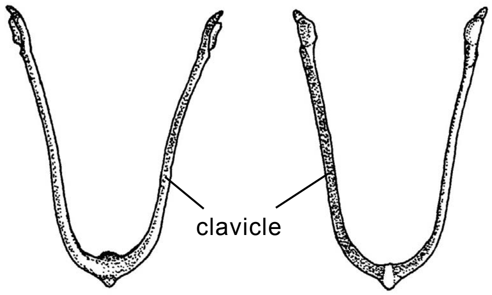


Sternum, *side* – Height 3 cm; length 5.5 cm

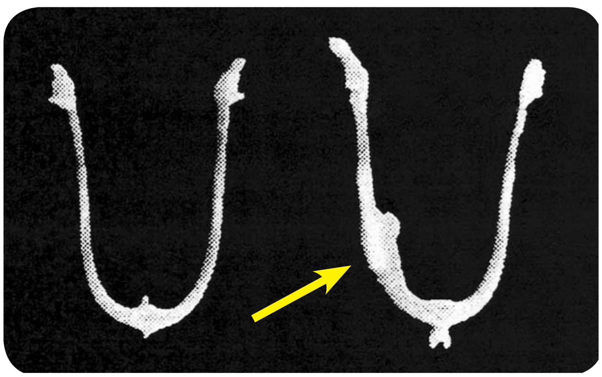


Sternum, *rear* – Height 3 cm; width 3.5 cm

Furcula (wishbone) of the American Crow – 3.6 cm long by 2.6 cm wide

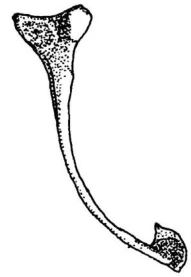


Furcula, *front* and *back*. 3.6 cm long by 2.6 cm wide; free end of each clavicle 1 cm wide; thinnest part of each **clavicle** 1 mm in both aspects x1

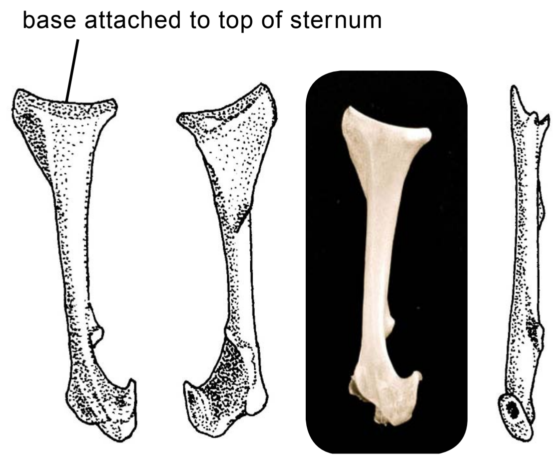


A normal **furcula** (wishbone) on the left, compared to a broken furcula that healed on the right; found at the Essex roost in **Ontario** in the 1980s, (photogram)

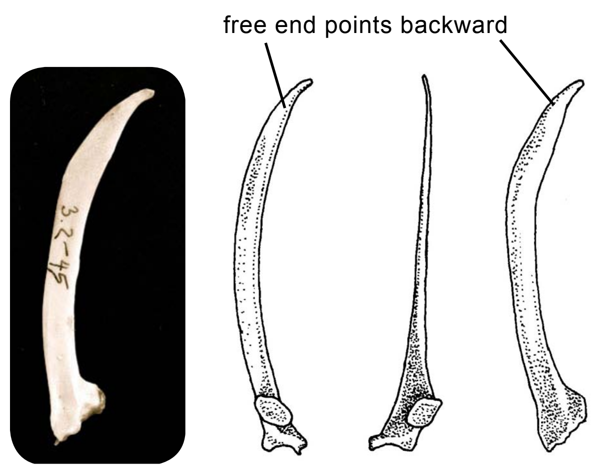
Furcula, weight 0.3 grams



Furcula, *side*



Coracoid, length 4 cm; ends 12 mm & 9 mm; midway thickness 3 mm; weight 0.5 grams

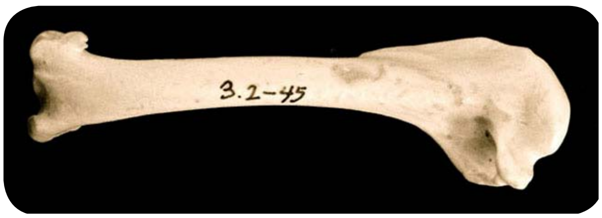


Scapula, length 4.7 cm; wide end 8 mm; midway 4 mm wide by 1 mm thick; weight 0.3 grams

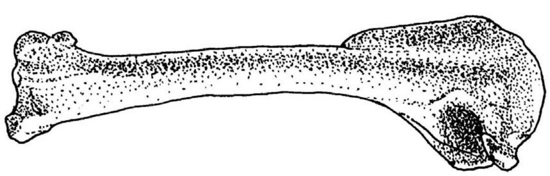
Wing bones

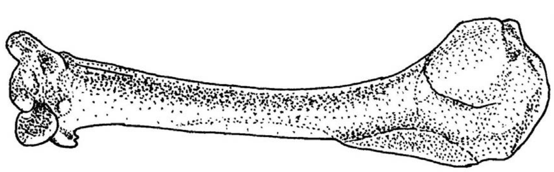
Humerus

The identification of recovered, old avian bones is always problematic. Fortunately, the humerus is fairly uniform across the family Corvidae. As a useful exercise, James Ashley looked at the topographical relationships of brachial muscles throughout the Corvidae. He wisely chose the American Crow as his model, and identified 16 parts on the head of the humerus (**Art 478**) at the large shoulder end in the anconal (elbow) view.



Wing bone of American Crow **– Humerus**, various aspects. Length 6.3 cm; end widths 1.7 cm and 1.4 cm; narrowest midway 4.5 mm; weight 1.6 grams





His measurements of 25 humeri [a65] –

Length 6.4 (5.6–7.1) cm
Width of head 1.8 (1.6–2.1) cm
Distal end width 1.6 (1.4–1.8) cm
Minimum shaft diameter 5–6 mm

From the Essex **Ontario** roost, my measurements of 37 humeri of American Crows dug from the woodlot floor –

Length 6.7 (6.1–7.2) cm
Average weight 1.6 grams

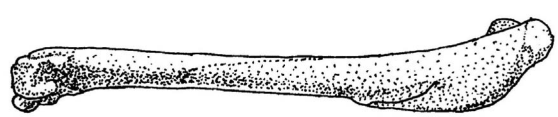
Ashley chose 6 features to create a key for the **humerus** to separate 13 species of Corvidae. The first 4 lines of the key identify and separate the Common Raven from the American Crow –

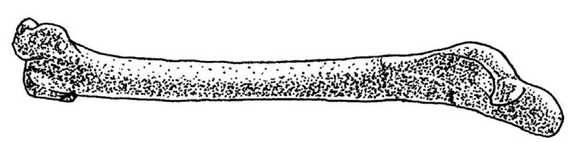
A Length more than 5.5 cm; shaft 0.5 cm or more in diameter; width of head more than 1.5 cm

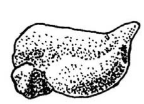
B Length more than 8 cm; width of head more than 2.3 cm; distal width more than 1.8 cm – ***Corvus corax*** (Common Raven)

BB Length less than 8.0 cm; width of head 1.5–2.2 cm; distal width 1.3–1.8 cm

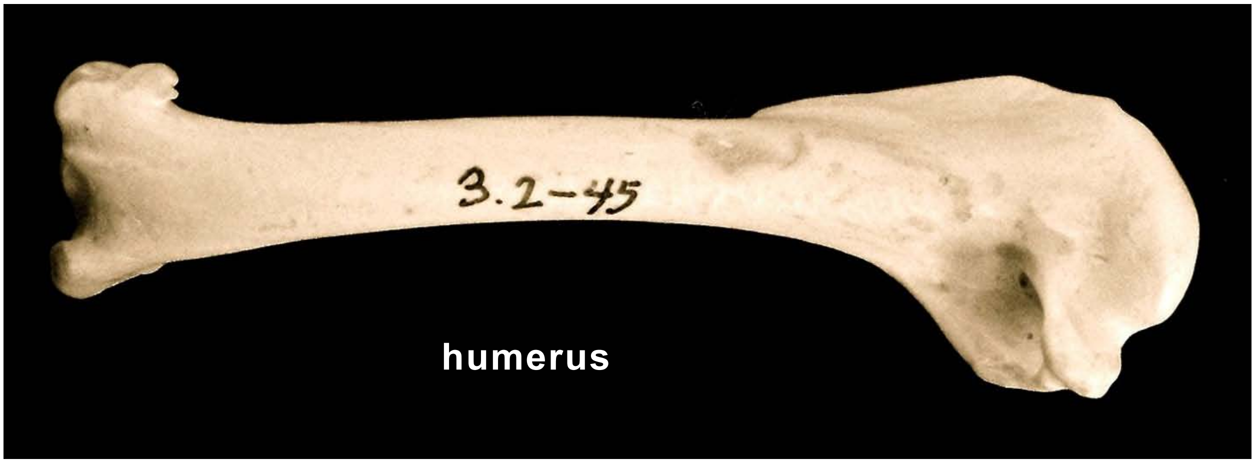
C Bicipital furrow distinct; surface between furrow and palmar ridge perpendicular or nearly so – ***Corvus brachyrhynchos***

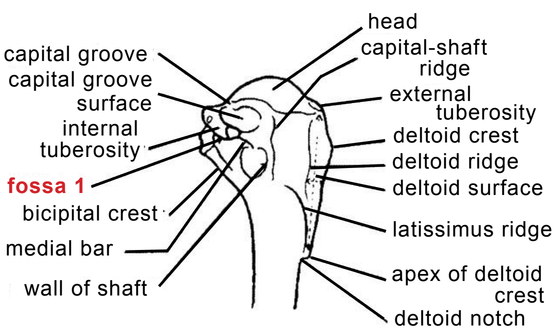






Humerus, *wide end* – Width 1.7 cm; depth 9 mm





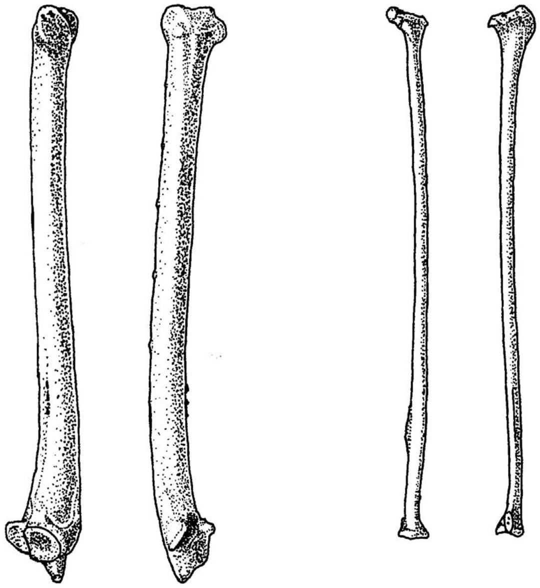
478. *Anconal* (elbow) view of the head of the humerus of an American Crow a65, Art by James Ashley,

One of the first distinguishing marks is the presence of a shallow pneumatic **Fossa I** in the head of the humerus above. The 16 names given to the crests, ridges, indentations and hollows of the head of the humerus define the areas where the 14 muscles are attached. For example, the external tuberosity (a rounded swelling) is at the proximal margin of the pectoral crest where Mm. supracoracoideus and deltoideus profundus brevis are inserted. And, for the "M. latissimus dorsi anterioris. ORIGIN: thoracic vertebrae – spines of the third and anterior half of fourth. INSERTION: on latissimus ridge of the anconal aspect. INNERVATION: by a twig from N. deltoideus rather than a separate branch from N. thoracodorsalis."

Bock examined the fossa (shallow depression) in the humerus wing bone of several passerines to determine its taxonomic use. The Jackdaw, *Corvus monedula*, has a typical single-fossa condition. The fossa is "distal to the internal tuberosity and posterior to the medial bar" 30b.

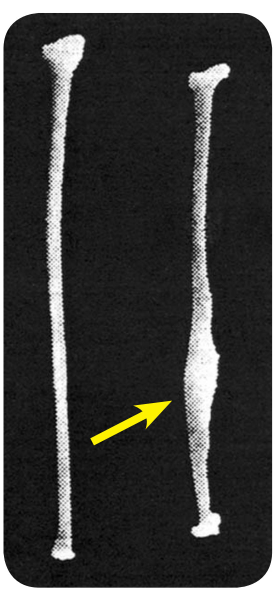
Early on, the single-fossa was considered a primitive condition and the double-fossa the more advanced feature. Families of birds were organized taxonomically according to the *supposition* that simplicity came first and slowly evolved into a more complex structure found in advanced families with 2 fossa in their members' humeri. Not everyone agreed with this supposition. But little was known about the functional meaning of the fossa, and how the single- and double-fossa condition in the humerus evolved.

Large floral buds of an American Elm in spring



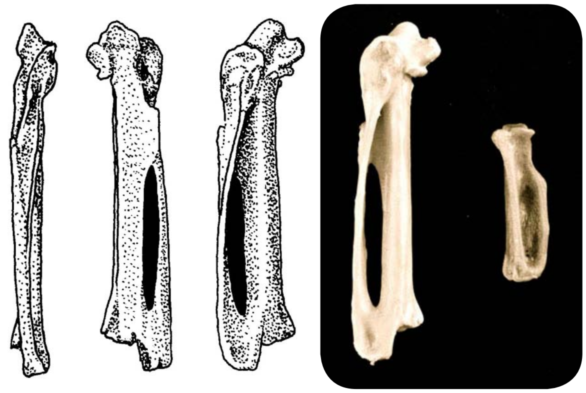
Wing bones of the American Crow – **ulna** (left) is 7.6 cm long by 4.5–5 mm wide (mid-way) with 10 papillae in 2 converging lines; the two ends are 10 and 9 mm wide. The **radius** (right) is 7 cm long by 1.7–3 mm wide and the two ends are 6 and 4 mm wide

Alexander Wetmore of the Smithsonian Institution in Washington placed his vote with those keeping the Corvidae away from the top of the oscines. The crow's humerus was similar to that in lower families such as the Tyrannidae and allies. These groups were rather primitive.



Wing bone – During my archeological dig in the early fall at the Essex roost in the 1980s, a healed **radius** (right) from a wing was uncovered. The 7 cm long radius on the left is intact. How long does a crow fly with a broken radius before it heals? (photogram)

Wing bones of the American Crow – **ulna** (left) is 7.6 cm long; **radius** (right) is 7 cm long



Wing bones of the American Crow – **carpo-metacarpus** (left) – Length 4.6 cm by 1 cm wide (both ends) by 4 and 2 mm thick on opposite sides. From the Essex roost – Length 4.8 (4.5–5.2); weight 0.7 grams (n 38)
Second digit, Phalanx 1 (far right) in photograph is 2.2 cm long by 5.5 mm wide (midway) by 2.5 mm thick; both ends are 6 mm wide; weight 0.2 grams (n 1)

Wetmore, therefore, kicked crows and their allies from the rooftop to near the basement of the oscinine families. The Fringillidae (finches) and related families were elevated to the penthouse suite based on actual facts [w64]. In 2011 and 2012, people were talking about the intelligence and playfulness of crows portrayed in videos on

the web and on TV. The general public knew nothing about the taxonomic struggles based on bone structure. The crows were the sexy superstars at the top of the avian world, no matter what the fine folks at the Smithsonian said in the 1950s.

Ulna and **radius**

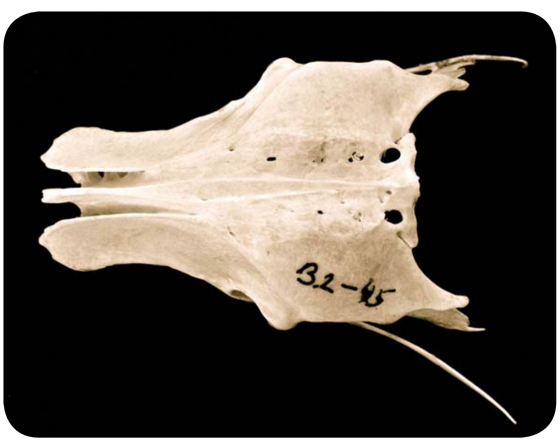
As we progress toward a wing's tip, the ulna and radius bones are next in line. These two parallel bones, without foramen, comprise the forearm. The stouter, slightly longer ulna bears 10 tiny, raised papillae along its trailing edge to which the large secondary flight feathers are attached. From the Essex roost, unearthed bones, air dried –

Ulna n 40	**Radius** n 30
Length 8.1 (7.4–8.7)	Length 7.3 (6.7–7.8) cm
Weight 1.5 grams	Weight 0.4 grams

As we near the tip of the wing, the bones are smaller. The carpomatacarpus has a fenestra (hole) 2 cm long by 2 mm wide. The **manus** is composed of several bones which help control the primary feathers. The 5 largest bones of the wing together weigh 3.7 grams (n 1).

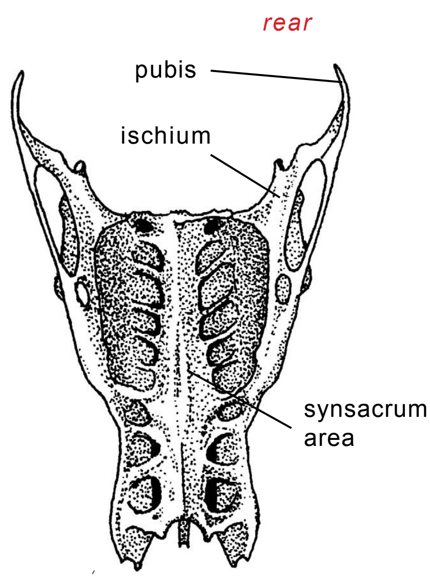
Pelvic girdle

The pelvic girdle is a fusion of 3 main bones – ilium, ischium and the pubis. It weighs 1.2 grams (n 1). The bones are fused to 11 spinal vertebrae.

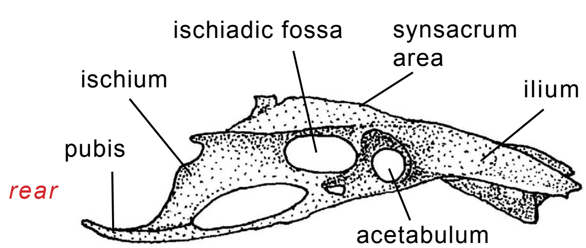


Pelvic girdle of the American Crow, *above* – 6.7 cm long by 3.9 cm wide by 2.5 cm deep; weight 1.6 grams (n 7)

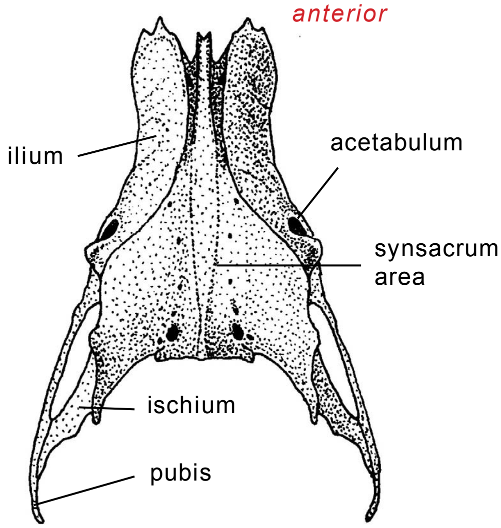
Pelvic girdle of the American Crow, *below* – 6.7 cm long by 3.9 cm wide by 2.5 cm deep



Pelvic girdle, *below* – Length 6.7 cm; width 3.9 cm



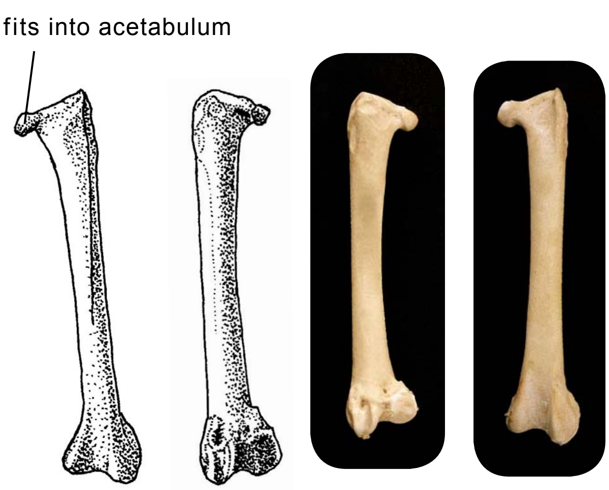
Pelvic girdle, *side* – Length 6.7 cm; depth 2.5 cm



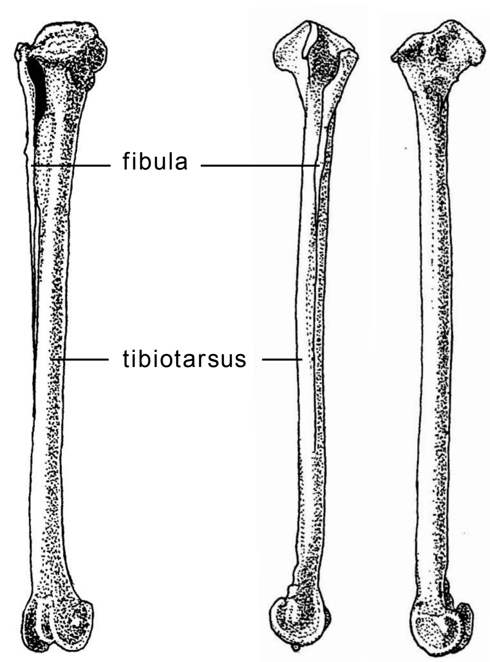
Pelvic girdle, *above* –
Length 6.7 cm; width 3.9 cm

Leg bones

Three long bones comprise the leg of a bird. The **femur** (thighbone) of the leg fits and articulates in a side cup, the acetabulum, of the ilium. Next in line, below the patella (kneecap) is the longest hidden bone, the **tibiotarsus**. A shorter fibula tapers to a fine point and extends along the side of the tibiotarsus. The **tarsometatarsus** (tarsus), a fusion of three metatarsal bones, begins with a few ridges at the proximal end and shallow sockets at the distal end where the 4 toes (digits) of the feet fit and radiate to the front and back. A crow walks and perches on its toes. The **tarsus** is the exposed foot bone measured by field workers and to which bands are attached. For the American Crow it averages 5.9 (5.6–6.3) cm long and is covered with black scales. The total weight of the 3 long bones of the leg is 2.7 grams (n 1).



Leg bone **Femur** (thighbone) – Length 5 cm by 4 mm wide (midway); ends 10 x 6 mm and 10 x 8 mm (widest). From the Essex roost – length 5.2 (4.7–5.7) cm; average weight 0.7 grams (n 16)



Leg bone **Tibiotarsus** – Length 8.3 cm by 3.5–4 mm; ends 13 mm (including fibula) and 8 mm; **fibula** length 5.2 cm, tapered, attached end 4 by 2 mm. From the Essex roost – length 8.7 (8.3–8.9) cm; average weight 1.3 grams (n 12)

Silky Milkweed

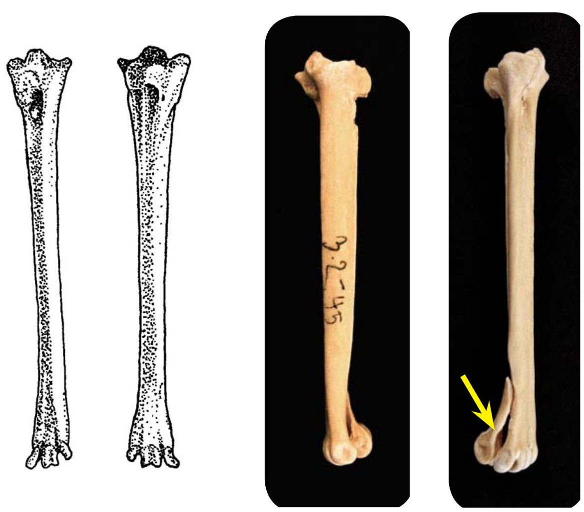
Leg bone **Tibiotarsus** is a fusion of bones to form the main leg bone. The **fibula** is a narrow remnant that tapers to a very fine delicate tip running parallel to the larger and longer **tibia**

Toes

The foot of the American Crow is one of 10 avian types, and is referred to as anisodactyl and scutellate. It is a typical songbird's foot. The first toe (hallux) points backward and the remaining 3 toes reach forward for an overall footprint length of 7.5–9 cm. It is used for griping and sometimes pushing. There are 10 small bones in the 4 toes. The dorsal black keratin scales number 57, and cover the tarsus and toes. This one count by three people was from a juvenile male found dead near the Chatham **Ontario** roost. By segment there are –

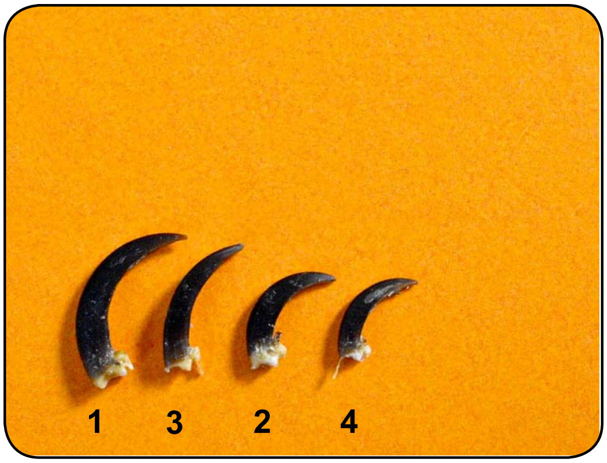
(1) Tarsus 8 scales
(2) Hallux toe # 1 14 scales
(3) Inside toe # 2 11 scales
(4) Middle toe # 3 13 scales
(5) Outer toe # 4 11 scales

The next measurements are from a preserved (70% alcohol) malnourished fledgling crow in **Winnipeg**. I named her Tarsus. Ten days after she left her nest, she was killed, but not eaten. Fine papillae on the bottom of her toe pads were mostly 0.3–0.5 wide, round to oval, and 5- or



Leg bone **Tarsometatarsus** (tarsus) 5.6 cm long by 3–4 mm wide (midway); ends 9–10.5 mm and 4–7 mm. From the Essex roost – length 5.9 (5.6–6.3) cm; average weight 0.7 grams (n 17). In the two photographs the bone to which the hallux (toe #1) is attached is shown (arrow)

Some toe bones of the American Crow – largest bone, the hallux is 2 cm long by 5 mm wide at the largest end; smallest bone 7 mm long; total weight of 18 toe bones was 0.7 grams



American Crow's toenails. The nail of the backward pointing toe, the hallux #1, is the longest. The #3 toenail has the least curvature of the 4 The 4 together weighed 0.5 grams

6-sided in some areas. They may reach 1 mm wide and are shallower along the sides of the toe pads. The back toe (hallux) and the inner 2nd toe appear to have 3 pads, while the 3rd and 4th toes have 4 pads, all of various lengths. The widths range from 3–6 mm; the widest are on the hallux. The 4 toes from their bases in a straight line to the tip of their toenails –

(1) Hallux (1st toe, backward) 3.5 cm long
(2) 2nd (inner toe) 3.2 cm long
(3) 3rd (middle toe) 4.3 cm long
(4) 4th (outer toe) 3.3 cm long

Length of the toenails in a straight line from their proximal dorsal surface to the tip (n 1) –

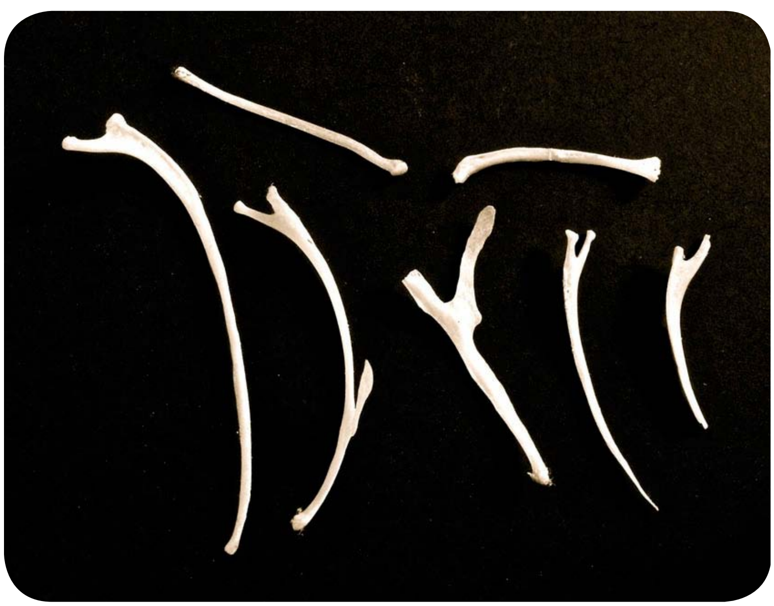
(1) Hallux toenail 15 mm long by 4 mm deep
(2) 2nd toenail 11 mm long by 3.2 mm deep
(3) 3rd toenail 11 mm long by 3.1 mm deep
(4) 4th toenail 9 mm long by 2.5 mm deep

The basal widths of the nails range from 1.3 (4th toenail) to 2 mm for the hallux. The hallux has the stoutest toenail, and the 4th toenail is the thinnest. The 2nd and 3rd toenails are about equal. On this male model, the nail of the middle toe # 3 has less curvature. Each toenail has a pale gray lower side border with thin flaking layers of keratin. The tip is light gray. The nails are smooth and slightly shiny. Flattened, the foot print is about 7.5 cm long from the tips of the nails on the back toe to the 3rd (middle toe). The narrowest point of the tarsus is 4 mm wide by 5 mm deep and right behind the toes. The longest dorsal scales near the middle of the tarsus are 7–8 mm.

Ribs and vertebrae

The ribs of the American Crow are curved, flattened and thin. The vertebrae are elegant pieces of sculpture. With their holes, they remind me of some objects by the artist Henry Moore (1898–1986). For 18 vertebrae like those on page 486, averages are – length 9.9 mm, width 10.7 mm, height 10 mm, width of spinal cord hole 2.4 mm. The central holes in each are mostly circular. The 18 pieces weigh a total of 1.7 grams (n 18).

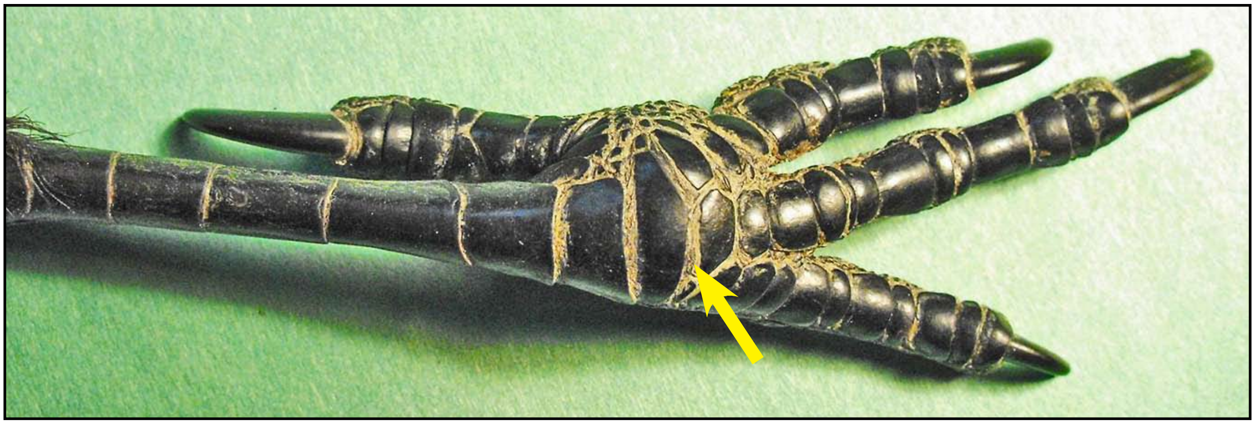
Berger compared the anatomy of the Red Bird-of-paradise to the "similar" American Crow and Blue Jay to determine taxonomic relationships. For the American Crow –



Some ribs of the American Crow – longest on left is 4.5 cm by 1.5 mm wide by 0.7 mm thick (midway); 14 ribs weigh 0.3 g

Right foot of Tarsus, in **Winnipeg**, early June, 2012

Below – **Papillae** about 0.5 mm wide on toes of a juvenile male American Crow found dead in early December 2011 at the Chatham, **Ontario** roost. **Bottom** – The entire 8.7 cm long right foot of the same male crow

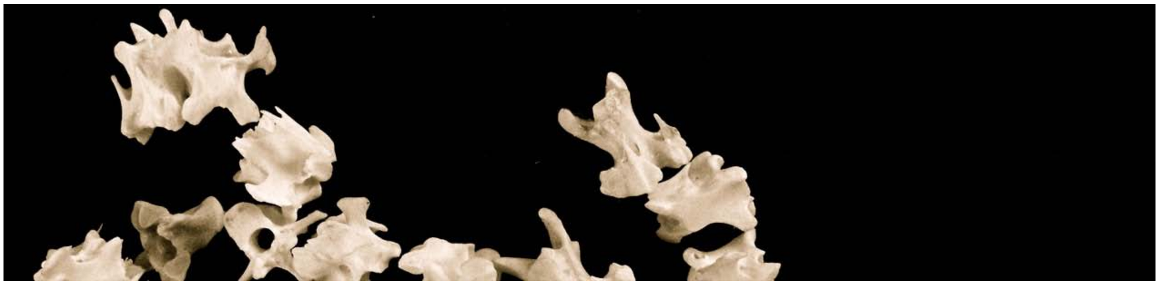


Yellow arrow above is the scale division where the tarsal length ends at the toes

Scale arrangement, from different angles, on the upper (dorsal) side of a juvenile male American Crow's foot – Chatham, **Ontario**. 57 scales adorn the upper side of the tarsus and the 4 toes of one foot

Hallux (toe #1)

Vertebrae out of formation



# of cervical vertebrae 14
# of cervicodorsal ribs 2
# of dorsal vertebrae 5
# of true ribs 5
# of thoracic ribs 1
# of fused vertebrae in synsacrum 11
# of free caudal vertebrae 7

The Blue Jay was similar, but with only 6 free caudal vertebrae, compared to 7 in the crow [b91]. For the American Crow a medley of skeletal data revealed –

(1) the topmost vertebra, the atlas, articulates with the occipital bone of the skull and is perforated by the odontoid process on the second cervical vertebra
(2) a roughly U-shaped os opticus and an os humeroscapulare are present
(3) neither of the 2 cervicodorsal ribs have an uncinate process
(4) all 5 true ribs articulate with the sternum
(5) the one thoracic rib which articulates dorsally with the synsacrum has no uncinate process. The sternal portion of this rib fuses with the sternal part of the fifth true rib
(6) the scapulo-coraco-clavicular articulation is different from that in non-passerine birds. The head of the furculum (wishbone) expands to form large anterior and posterior processes. The anterior process articulates with the head of the coracoid. Near its base the posterior process articulates with the medial surface of the acromion process of the scapula. The acromion process is small and well hidden between the much larger heads of the coracoid and the furculum
(7) digit 3 (middle toe 3, forward pointing) is 5.2 cm which is considerable longer than the hallux (toe 1, backward pointing) at 3.8 cm
(8) there is an increase in length of the 3 wing elements from the proximal (humerus 6.7 cm) to the distal end (manus 8.6 cm)
(9) leg and foot bone lengths below (n 1)

Femur 5.2 cm
Tibiotarsus 9.2 cm
Tarsometatarsus (tarsus) 6.2 cm
Hallux 3.8 cm (back toe)
Digit 2 3.6 cm (inner toe)
Digit 3 5.2 cm (middle toe)
Digit 4 3.7 cm (outer toe) [b91]

The average weight of 3 complete skeletons I recovered after boiling dead birds for a few hours to remove the meat was 27 (22–30) grams, which is 5.4% of a 500 gram American Crow.

Archaeological digs

Avian relics occasionally include a bone from the American Crow. One dated to the late Pleistocene (10,000 Carbon-14 years before present; wiki) came from freshwater pond deposits at the Ingleside Pit in San Patricio County, near the southern tip of **Texas**. The remaining distal end of a tarsometarsus (30967–1754 in the Texas Memorial Museum) belonged to an American Crow [f15].

Two shell heaps were excavated along the shore of Buena Vista Lake, Kern County in **California**. The numerous relics were probably not over 500 years old. Bones of coots, grebes, ducks and geese were common. At one site, 21 bones of the American Crow were identified; at the second site, bones of the crow were not found [d32].

Bones of birds were uncovered at a First Nations' village in **Ohio**. The site was believed to be

active in the 1400s–1500s. Among 31 bones identified to species, the crow and raven were present, as were bones of the Passenger Pigeon and Trumpeter Swan [g49]. Crow remains were among the items in kitchen middens at Cahokia Mounds in **Illinois** (AD 1200–1550) [p13]. In a dig among the remains from AD 450–750, the bones of four crows were found [p14]. One can only guess as to how crows were thought of and used centuries ago. At the huge Emeryville Shellmounds in west-central **California**, the recovery of bird bones indicated hunters influenced avifauna in the region of the San Francisco Bay area. The time span was about 2600–700 years before present (BP). The collection included 5,736 bird bones. The identified bones of crows were coracoides, scapulas, humeri, ulnae, radii, tibiotarsi and tarsometatarsi, etc [87b].

Hargrave investigated the remains of birds at several First Nations' sites in northeastern **Arizona** and southern **Utah**. In the San Francisco Mountain range near Flagstaff, one humerus of the American Crow was unearthed. Material at the sites ranged from 700 and 1300 AD [h32].

Muscles

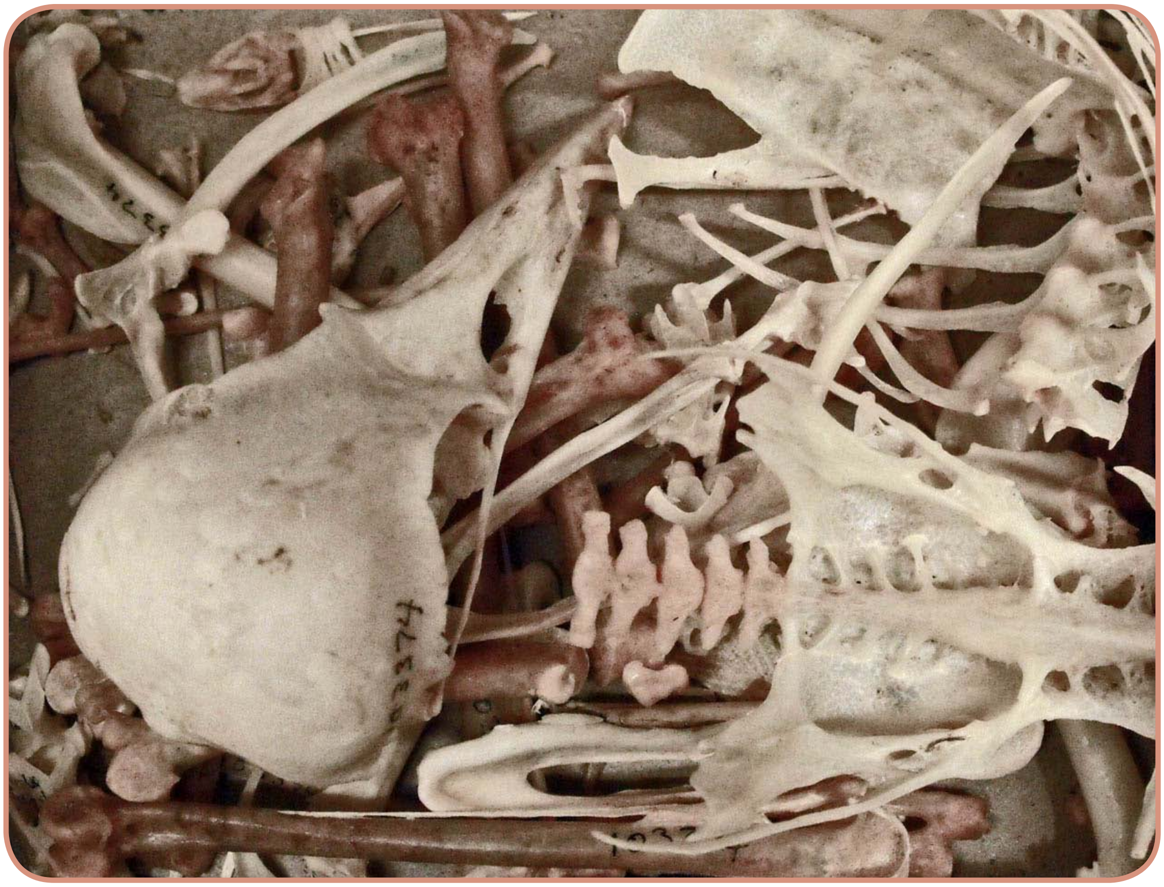
Berger provided additional data on the muscles of the American Crow [b91]. Regarding the crow's wing muscles, the following five were **ABSENT** –

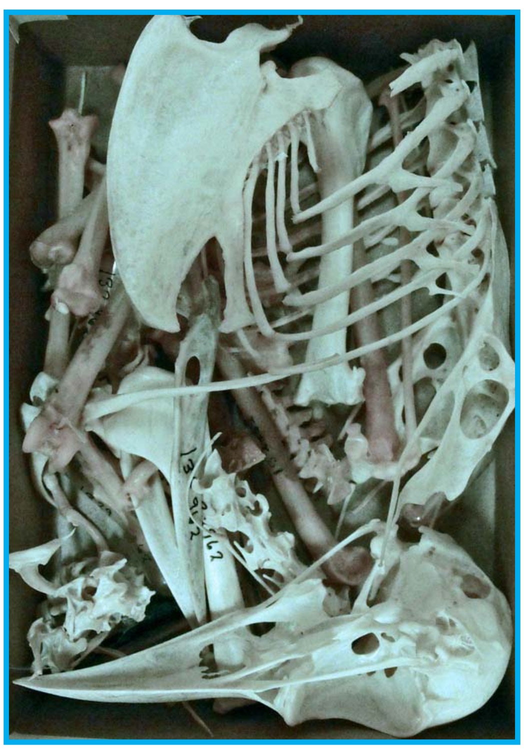
(1) Latissimus dorsi metapatagialis
(2) Biceps propatagialis
(3) Entepicondylo-ulnaris
(4) Extensor pollicis brevis
(5) Flexor metacarpi brevis and possibly
Flexor pollicis (seen clearly only in 1 wing by another researcher)

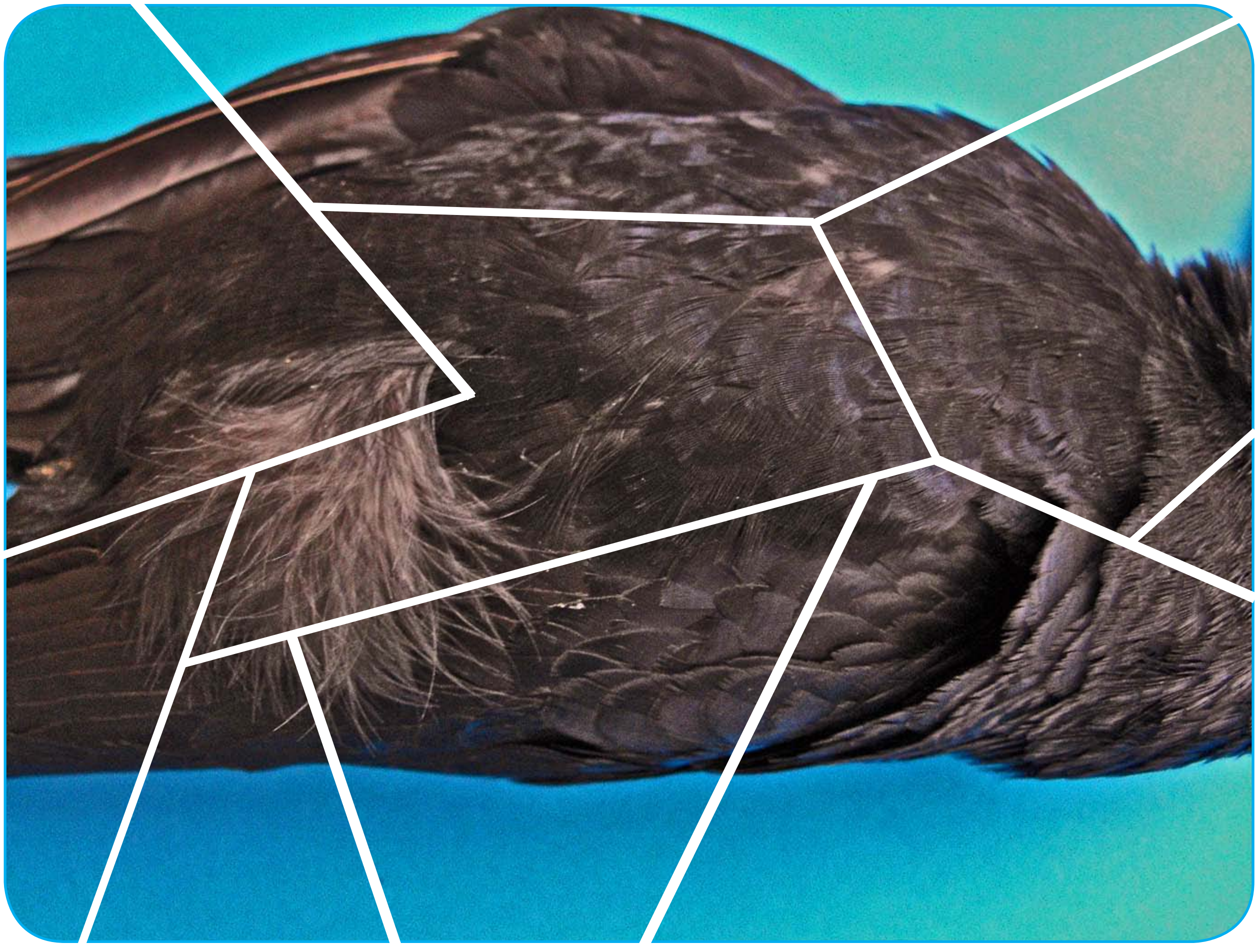
Six wing muscles were **PRESENT** –

(1) M. abductor indicis is fairly well developed
(2) Pars propatagialis musculi cucullaris sends a tendon to insert on the tendon of M. tensor patagii

Tibia and the narrow fibula form the leg's tibiotarsus







longus
(3) The tendon of insertion of M. latissimus dorsi, pars posticus perforates the origin of the humero-triceps
(4) M. subcoracoideus originates from the dorsal end of the coracoid
(5) M. anconeus inserts on the proximal half of the ulna
(6) The leg muscle formula is ACXY

Nine leg muscles of the crow were **ABSENT** –

- **(1)** Gluteus medius et minimus
- **(2)** Ambiens
- **(3)** Pars iliofemoralis of the piriformis
- **(4)** Popliteus
- **(5)** Extensor proprius digiti 3
- **(6)** Extensor brevis digiti 4
- **(7)** Abductor digiti 2
- **(8)** Adductor digiti 2
- **(9)** Adductor digiti 4

Four leg muscles were **PRESENT** –

(1) M. sartorius arises from the anterior portion of the median dorsal ridge and the neural spine of the last dorsal vertebra. It has a single head
(2) M. obturator externus arises by two heads, which fuse before inserting by a single tendon
(3) The tendon of M. flexor perforatus digiti 2 is perforated by the tendon of M. flexor perforans et perforatus digiti 2 and the tendon of M. flexor digitorum longus
(4) M. semitendinosus has an origin from the free caudal vertebrae [b91]

Flight and leg muscles

Muscle fibers, the contractile cells of skeletal muscles in birds are of 2 types –

(1) fast twitch
(2) slow twitch

In muscle "each myosin (a fibrous protein that combines with actin to form the contractile filaments of muscle cells) molecule is a hexamer (6 parts) consisting of two heavy and four light chains."

Within the M. pectoralis pars thoracicus muscle fibers are myosin heavy-chains (MyHC) that contribute to the muscle mass. Dissimilar MyHC isoforms (several different forms of the same protein) are defined by immunocytochemical methods. "the presence of different isoforms in different fast-twich fiber types suggests a correlation between isoform and contractile function."

Blocks of muscle were removed from near the keel of the sternum in 31 species of birds. Fast-twitch fibers were divided into FG (Fast Glycolytic) and FOG (Fast Oxidative-Glycolytic) types by the "biochemical pathways used to produce the energy for contraction." The FOG fibers, of smaller diameter, were found in migratory birds due to their "capability of sustained rapid contraction." For the American Crow, which had only FOG fiber types, 4 of 8 monoclonal antibodies from chickens were specific to the different MyHC isoforms in the flight muscle of the crow [26r].

Muscle fiber types in the pectoralis muscle (PM) provide the downstroke for the wing during flight. Superficial and deep muscles were sampled from the PM. In the superficial sample, 25% of the fiber types were intermediate, and 75% were red fibers containing the smallest fibers with the greatest density of mitochondria. In the deep muscles, 15% were of the intermediate type and 85% were red fibers. No white fibers were present in this muscle of the American Crow [25r].

The pectoralis major muscle is used in liftoff. The pectoralis major and minor muscles were examined in a dozen small passerines (sparrows, warblers, a crossbill, etc). It was often composed of one kind of fiber and was dark red in color from an embracing supply of blood. When a longitudinal section of the pectoralis major was stained, the lipid bodies and mitochondia became dark spots between and parallel to the myofibrils. Hence, they are often referred to as dark fibers.

Pectoralis minor muscles usually contain dark and pale fibers. The dark fibers power a wing's upstroke, and the pale muscle fibers hold the base of a wing in position. When stained with Sudan black B, they revealed smaller interfibrillar content than the dark fibers [s12, s13].

Feathers

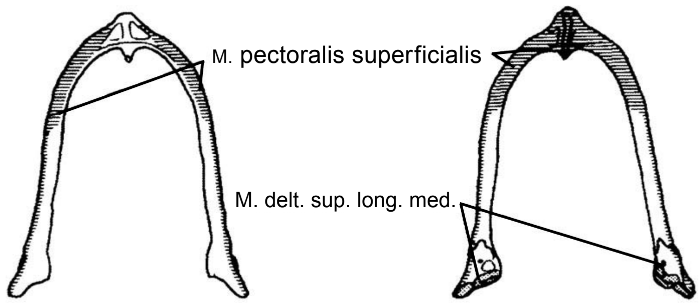
Feathers are thin, lightweight structures that define and identify a bird. In an adult American Crow, they appear black at a distance, but in the hand or through field glasses, they reveal various sheens of blue and violet. Highlights and shadows dance in the company of sunshine.

The look of feathers reveals more than the identity of a species and its sex. In favorable light they present telling marks and degrees of wear.

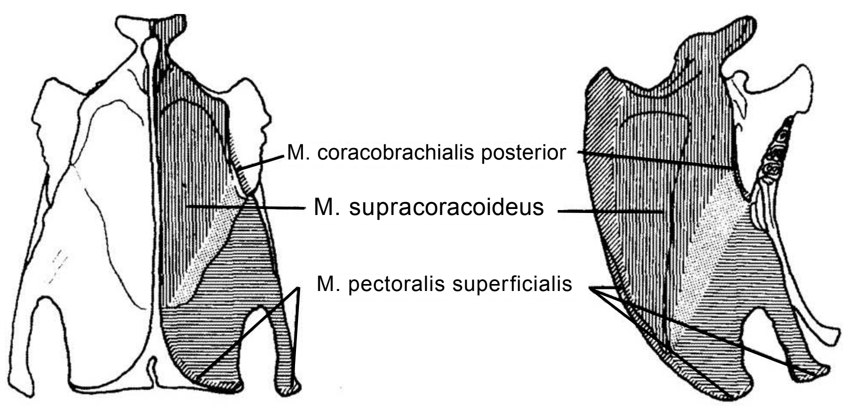
Growth bars

These bars are "alternate light and dark, normal angular markings across the web [vane] of many feathers." On both sides of the rachis growth bars are easily seen on the large, dark, wing and tail feathers of juvenile and adult crows. Growth

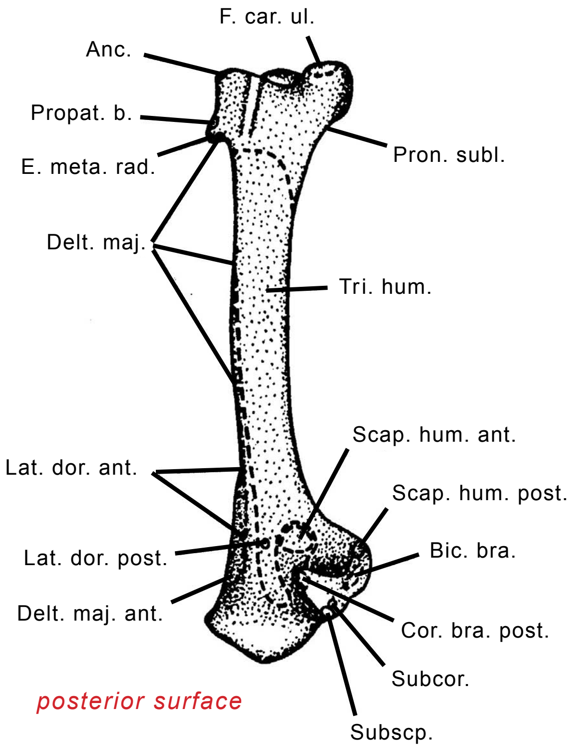
Common Raven at the edge of the Grand Canyon in Arizona, 11 November 2011



491. Furcula (wishbone) of the American Crow, showing areas of origin of its muscles; *ventral* (left); *dorsal* (right); Art by James Ashley, a65, © Cooper Ornithological Society



491a. Sternum of the American Crow, showing areas of origin of its muscles, x1; *ventral* (left); *lateral* (right); Art by James Ashley a65, © Cooper Ornithological Society

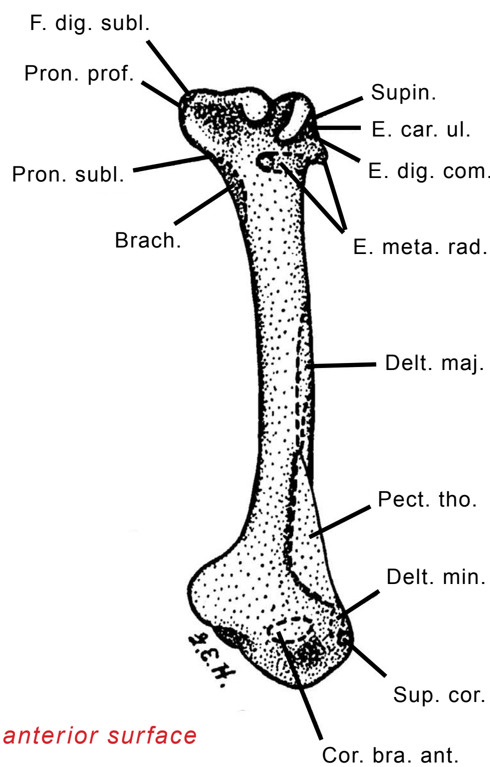


posterior surface

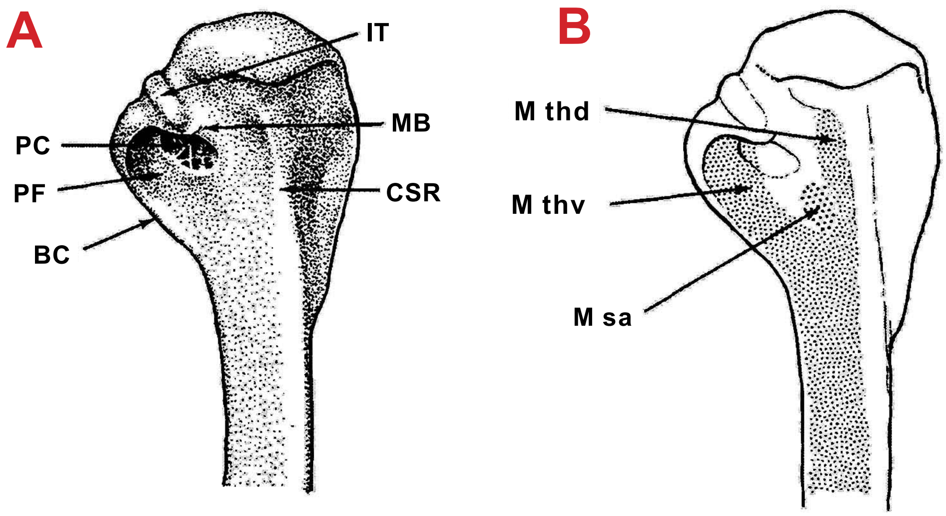
492. Muscle attachments on the **humerus** of the American Crow, 51h, © American Midland Naturalist, with permission. Art by George E Hudson

Muscle abbreviations of humerus (wing) –

(1) **Anc.** Anconaeus
(2) **Bic. bra.** Biceps brachii
(3) **Brach.** Brachialis
(4) **Cor. bra. ant.** Coracobrachialis anterior
(5) **Cor. bra. post.** Coracobrachialis posterior
(6) **Delt. maj.** Deltoideus major
(7) **Delt. maj. ant.** Deltoideus major anterior
(8) **Delt. min.** Deltoideus minor
(9) **E. car. ul.** Extensor carpi ulnaris
(10) **E. dig. com.** Extensor digitorum communis
(11) **E. meta. rad.** Extensor metacarpi radialis
(12) **F. car. ul.** Flexor carpi ulnaris
(13) **F. dig. subl.** Flexor digitorum sublimis
(14) **Lat. dor. ant.** Latissimus dorsi anterior
(15) **Lat. dor. post.** Latissimus dorsi posterior
(16) **Pect. tho.** Pectoralis thoraica
(17) **Pron. prof.** Pronator profundus
(18) **Pron. subl.** Pronator sublimis
(19) **Propat. b.** Propatagialis brevis
(20) **Scap. hum. ant.** Scapulohumeralis anterior
(21) **Scap. hum. post.** Scapulohumeralis posterior
(22) **Subcor.** Subcoracoideus
(23) **Subscp.** Subscapularis
(24) **Sup. cor.** Supracoracoideus
(25) **Supin.** Supinator
(26) **Tri. hum.** Triceps humeralis

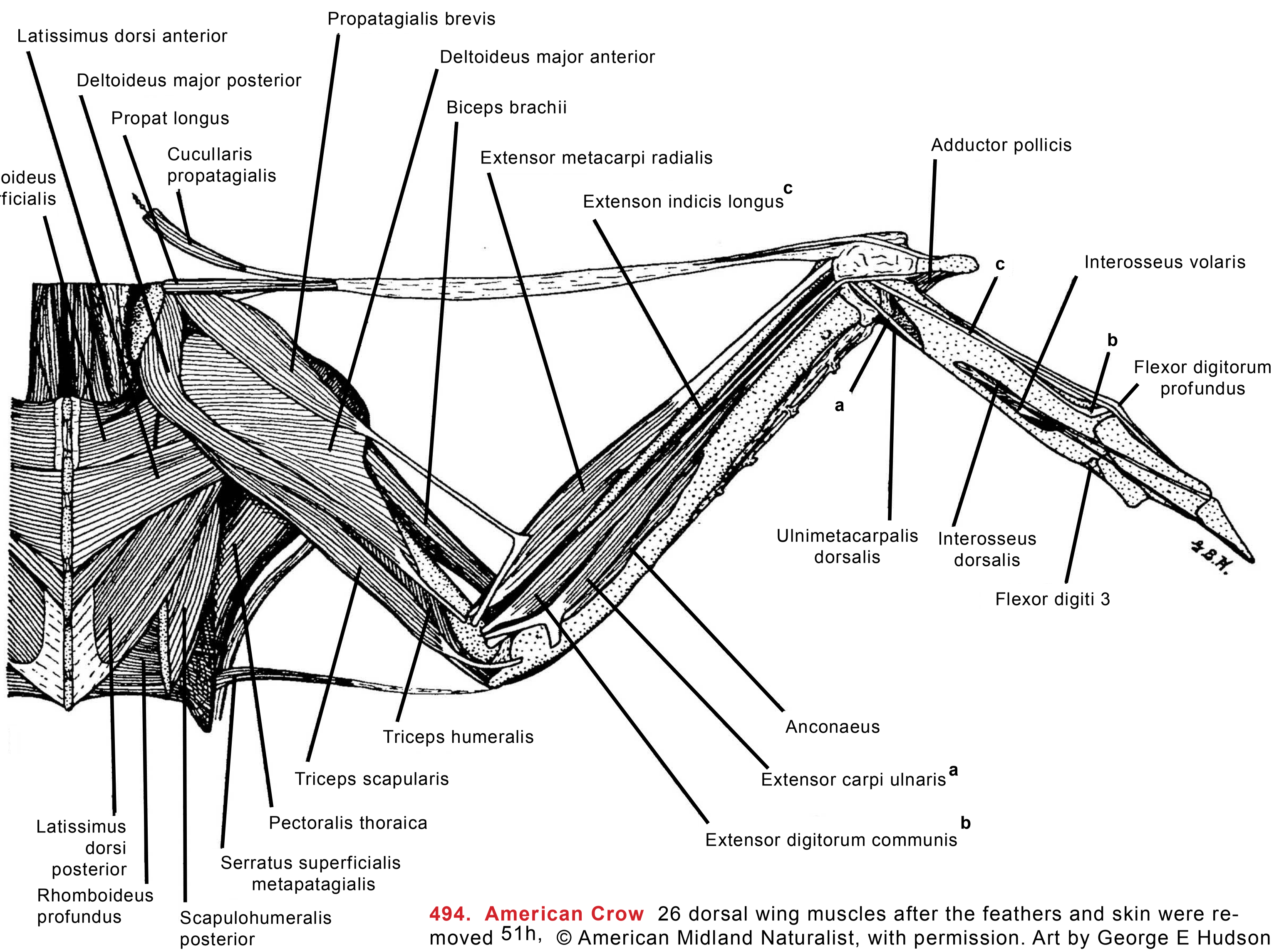


anterior surface

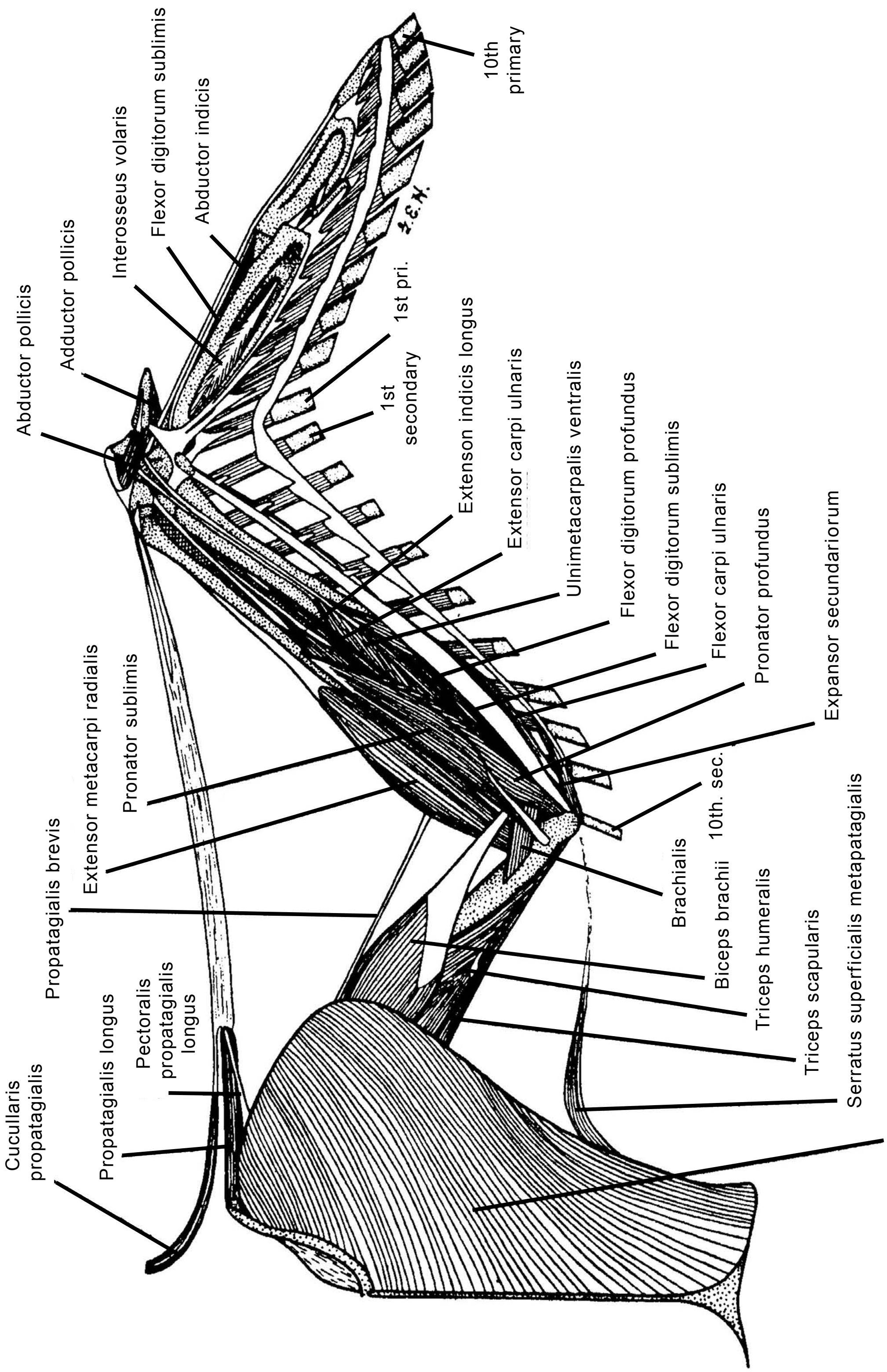


493. “The right **humerus – (A)** of *Corvus* (Jackdaw) to show the pneumatic fossa. Abbreviations – **BC** = bicipital crest, **CSR** = capital-shaft ridge, **IT** = internal tuberosity, **MB** = medial bar, **PC** = pneumatic canal, **PF** = pneumatic fossa. The muscle attachments associated with the pneumatic fossa in *Corvus* are depicted in **(B)**. The large area of fine stippling shows the origins of the dorsal (**M thd**) and the ventral (**M thv**) heads of the M. triceps humeralis. The small area of coarse stippling shows the area of insertion of M scapulohumeralis anterior (**M sa**), located at the distal end of the pneumatic fossa. Art not to scale” 30b,

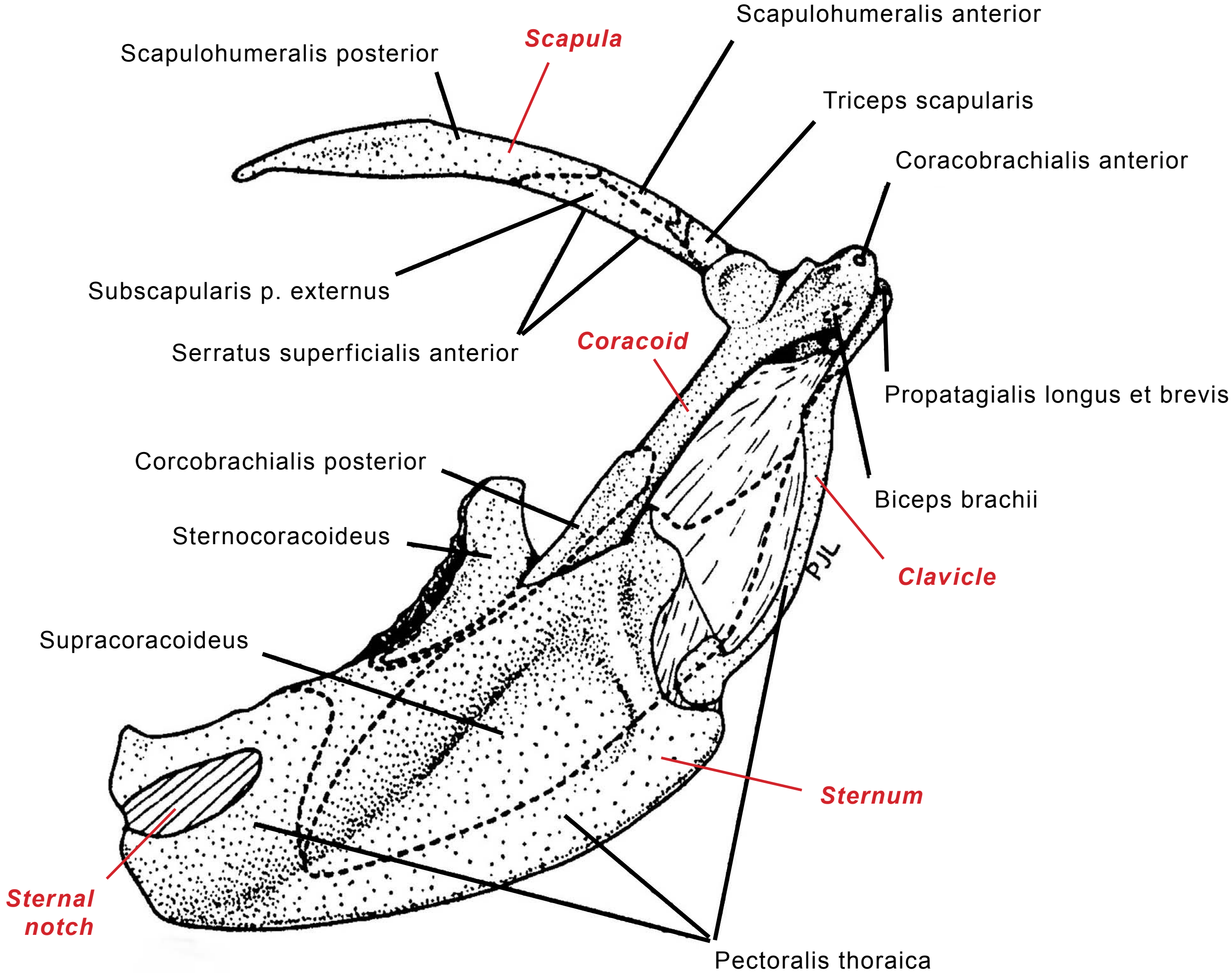
Bulrushes and brome



494. American Crow 26 dorsal wing muscles after the feathers and skin were removed 51h, © American Midland Naturalist, with permission. Art by George E Hudson



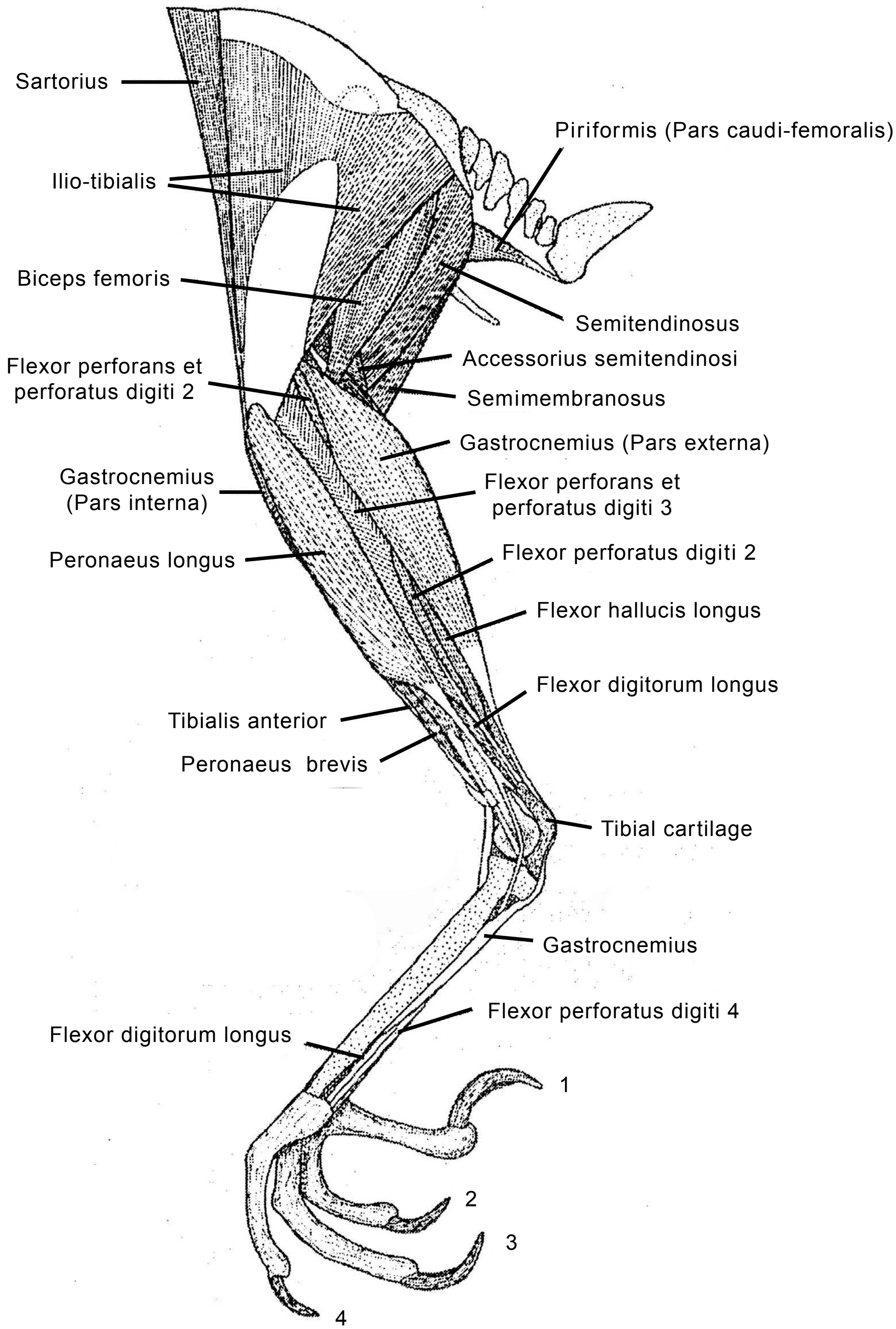
495. American Crow 25 ventral wing muscles after the feathers and skin were removed 51h, © American Midland Naturalist, with permission. Art by George E Hudson



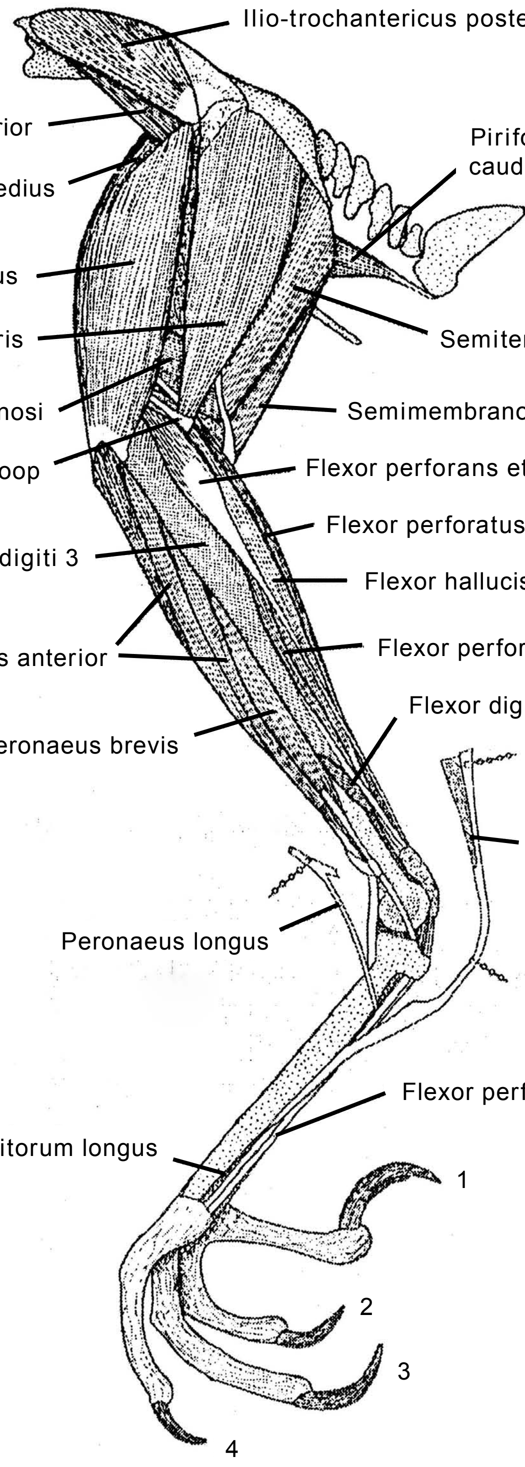
496. American Crow Positions of muscle attachments on the pectoral girdle – *lateral view* 51h, © American Midland Naturalist, with permission. Art by Patricia J Lanzillotta

Samaras of Manitoba Maple

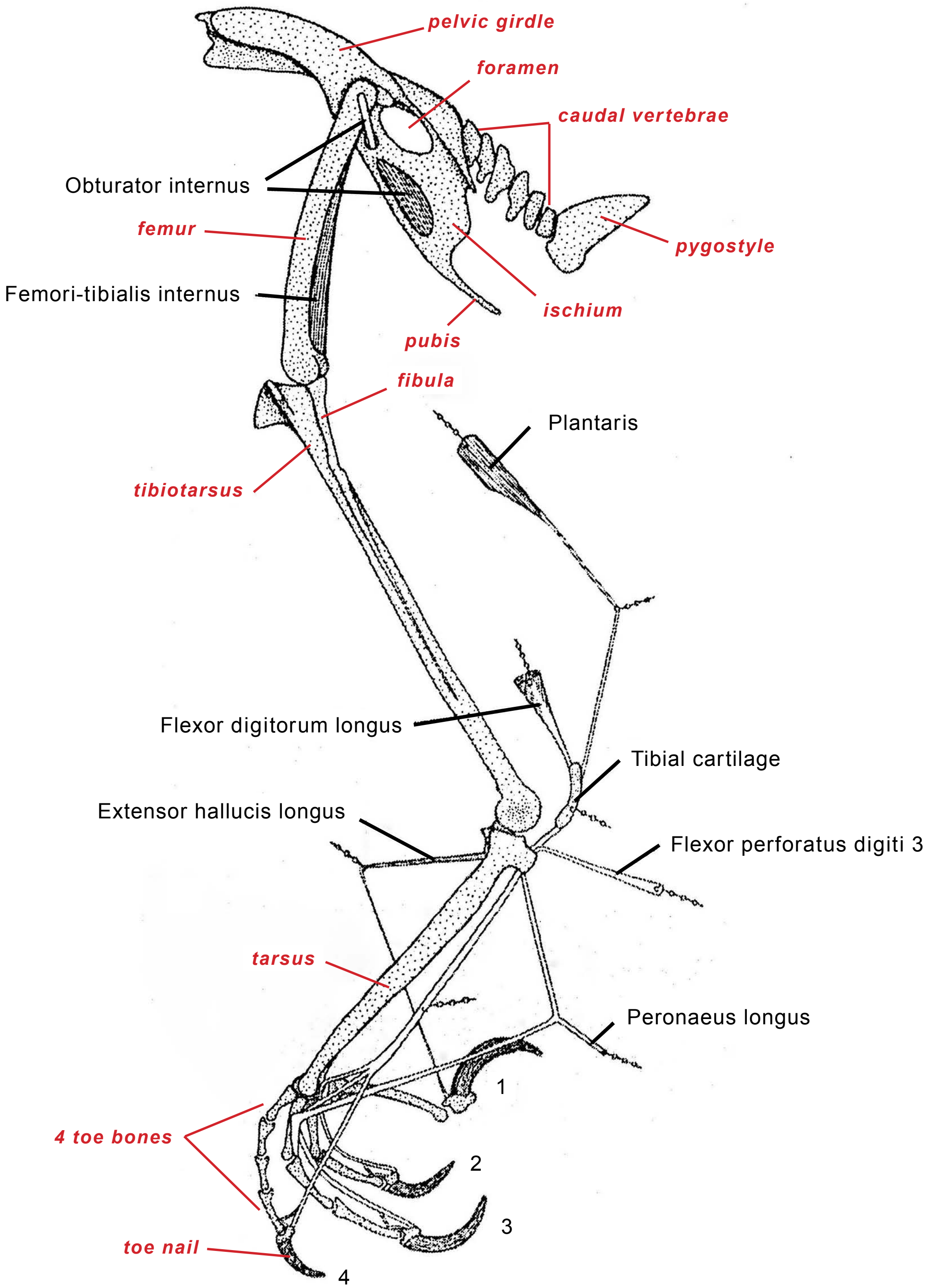
Siliques (pods) of Stinkweed



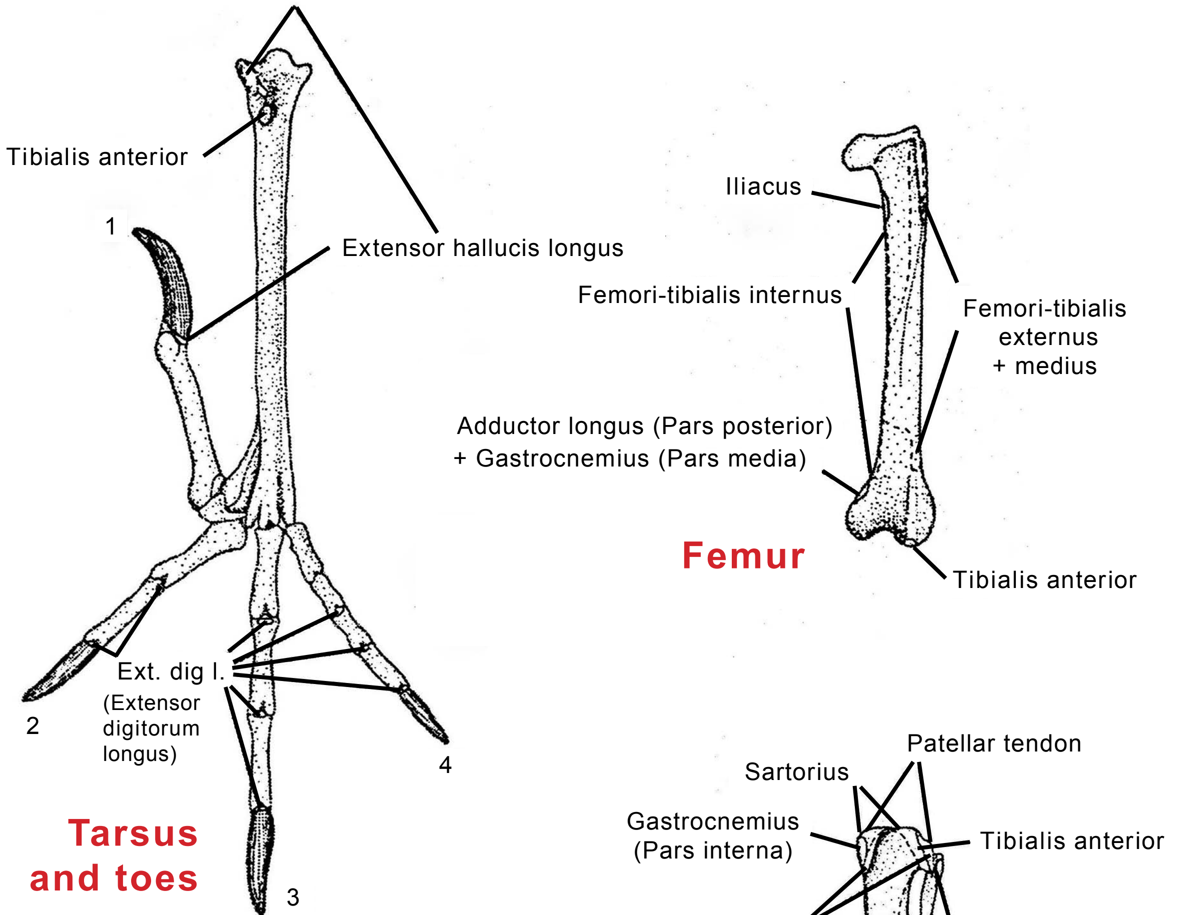
497. American Crow 21 superficial muscles on the left leg 50h,

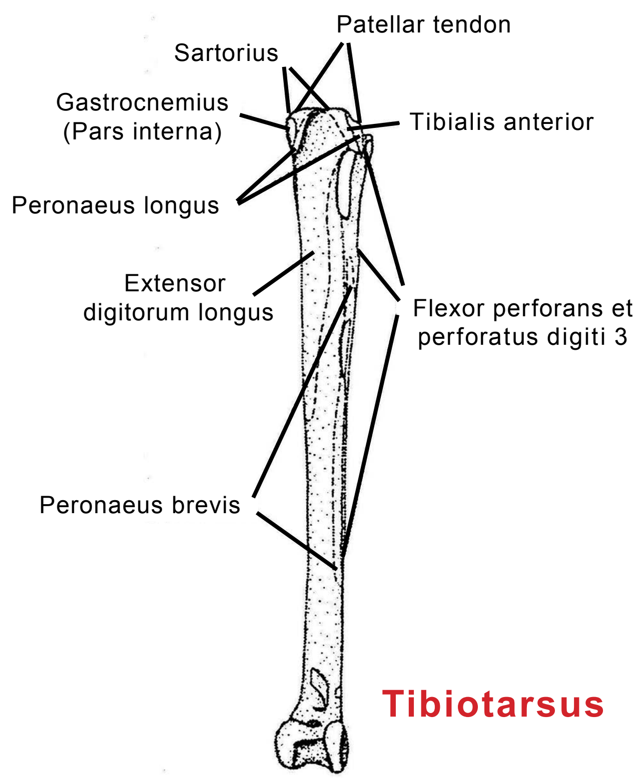


498. American Crow Second layer, 22 muscles of the left leg. The 4 superficial muscles – (1) Sar. (1) Il tib. (1 & 1) Gas (P. int. & ext.) & (1) Per. long. have been removed from the picture 50h, © American Midland Naturalist, with permission. Art by George E Hudson



499. American Crow The deepest (innermost) layer of muscles of the left leg 50h,
© American Midland Naturalist, with permission. Art by George E Hudson

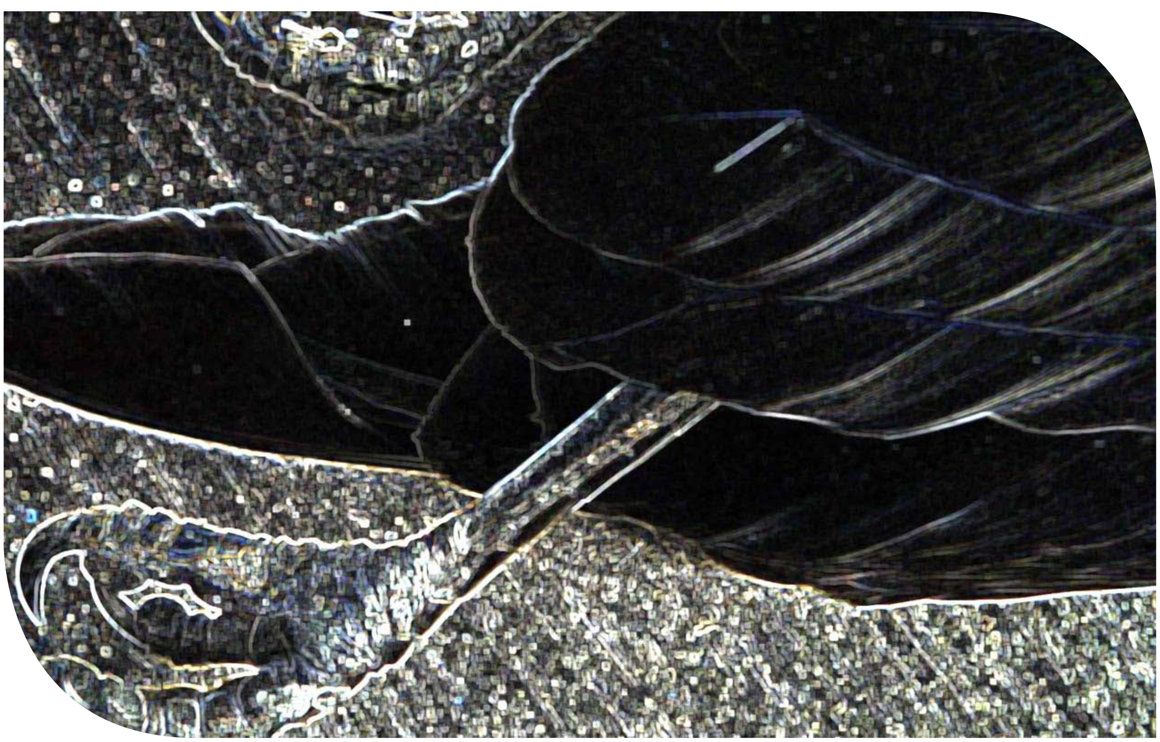




Fruit of Nannyberry ripens as the migration of crows begins in mid-September from **Manitoba**

500. American Crow Bones of the left leg; areas of muscle attachments – **tarsometatarsus** (tarsus) plus 4 digits; **femur** and **tibiotarsus** 50h, © American Midland Naturalist, with permission. Art by George E Hudson

Off-center images of an American Crow



bars form as a feather emerges from its soft, blue calamus sheath. The bars are thought to indicate a temporary lack of overnight nutrition (crow nestlings are only fed during the day), which lessens the formation of microscopic barbules. Crow nestlings in captivity lost about 10 grams in weight at night, but increased their weight the next day when fed. Continuing, "dark bars are diurnal in development and the light bars nocturnal." In light and dark growth bars, the average is about 21 barbules per 250 microns (µm) [p10]. The average

Wing feather vanes and rachides. Dark and light growth bars are visible on the far right vane (arrow)

human hair is about 100 microns wide (wiki).

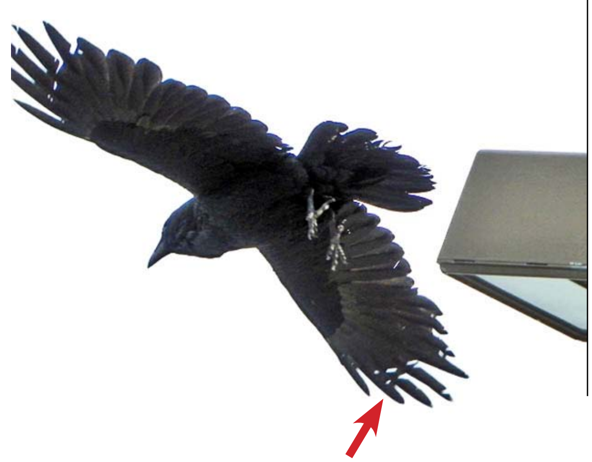
A growth bar forms at a specific downward angle from the rachis across a vane. It is seen by tilting a feather at a suitable angle to the light. Some bars are faint. Growth bars in many species range from 62º–95º. The American Crow and Common Raven both have bars at 68º to the rachis on their tail feathers [26w].

Fault bars

Fault bars are more obvious than growth bars and a good indicator of stress due to food, handling, or disease, etc. Fault bars are frayed or missing parts of vanes running almost perpendicular to a feather's rachis. Poorly developed barbules cause fault bars, some of which are light lines, others are holes that may cause feather breakage.

A population of about 1,919 American Kestrels in **Saskatchewan** were examined from 1990–1997. Fault bars were found on 17% of tail and primary feathers on females, and 14% on males. Females with many fault bars began their clutches at later dates than females with fewer bars, indicating they may have been poorer hunters. Females with many fault bars also had a lower probability of survival. Fault bars may indicate susceptibility to stress [37b].

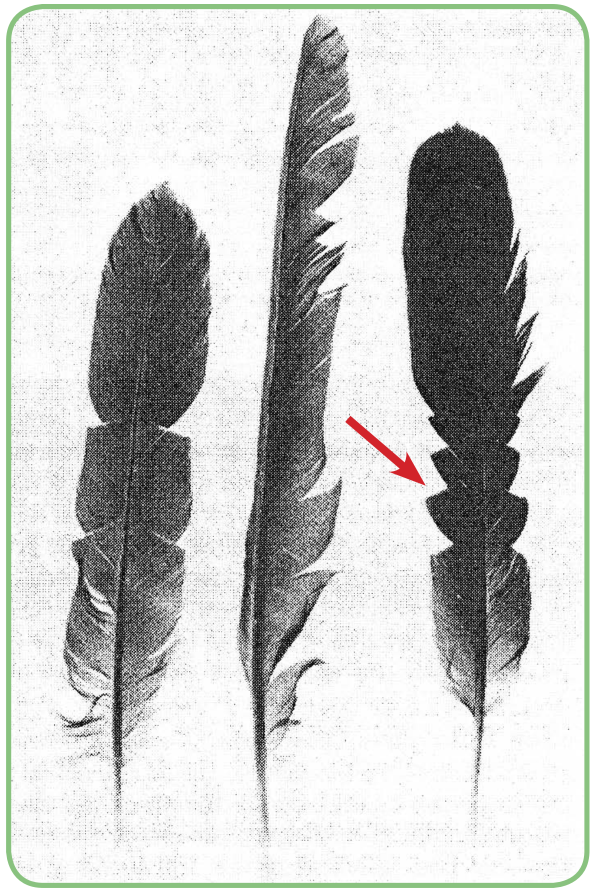
In **Norway**, 1,072 Hooded Crows were shot from 1975–1981. Slagsvold sexed the birds by their gonads and examined the third primary from the outer edge (P8), and other large feathers for fault bars. Juvenile crows had many more fault



Fault bars on the primary wing feathers and a ragged tail in mid-April indicate this is probably a yearling Common Raven, by our calendar

Feather colors help to identify a Hooded Crow in Trieste **Italy**, © by Anne Adkins, with permission

bars, especially on their tail feathers, than did the adults. Overall, juvenile males exhibited more marks than juvenile females. Adult males had the fewest. This may indicate male nestlings were more difficult to raise (required more food) to fledging stage than females. This in turn, may alter the sex ratio in a population to favor females, and exert a selective pressure for smaller males [s90].



Typical feather fault bars (notches, red arrow) in tail feathers and P8 primary (middle) of the Hooded Crow [s90], © Journal of Avian Biology, with permission

Glands, ears, eyes, etc

Uropygial (preen) gland

This gland is located dorsally just before the tail feathers (**photo page 509**). It secretes oil that birds use in their daily preening to maintain their feathers. However, ostriches, mesites (near flightless birds endemic to Madagascar), parrots, woodpeckers, and others lack this gland, yet their feathers and lives are normal. Perhaps the gland is internalized in these species.

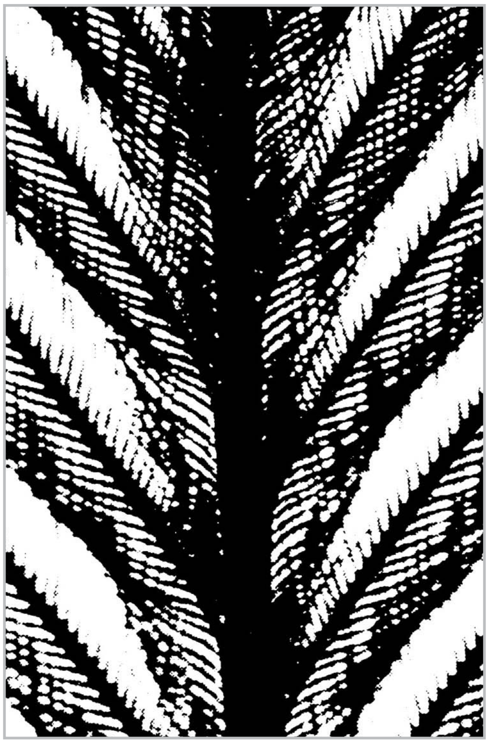
European Hoopoe, *Upupa epops*, nestlings 11–17 days old produced dark smelly secretions with 10 volatile compounds such as butanoic acid, 3-phenyl propanoic acid, and phenol. These dark

Bur Oak with a family of American Crows

secretions, also produced by breeding females, gave antimicrobial activity against a wide set of 19 bacterial strains (both gram positive and negative), including feather-degrading, rod-shaped bacilli and other pathogens. When the uropygial gland was injected with the wide-spectrum antibiotic amoxyciline, there was a reduction of volatiles in the dark secretions, indicating they were produced by symbiotic bacteria. The most common bacteria cultivated was *Enterococcus faecalis*, a nonmotile, facultatively anaerobic microbe, along with other *Enterococcus* species. White secretions from both sexes between breeding seasons were mostly waxes and lacked volatile compounds. Other birds also had seasonal changes in chemical composition of secretions from the uropygial gland [m45]. No work of this nature has been done on the American Crow.

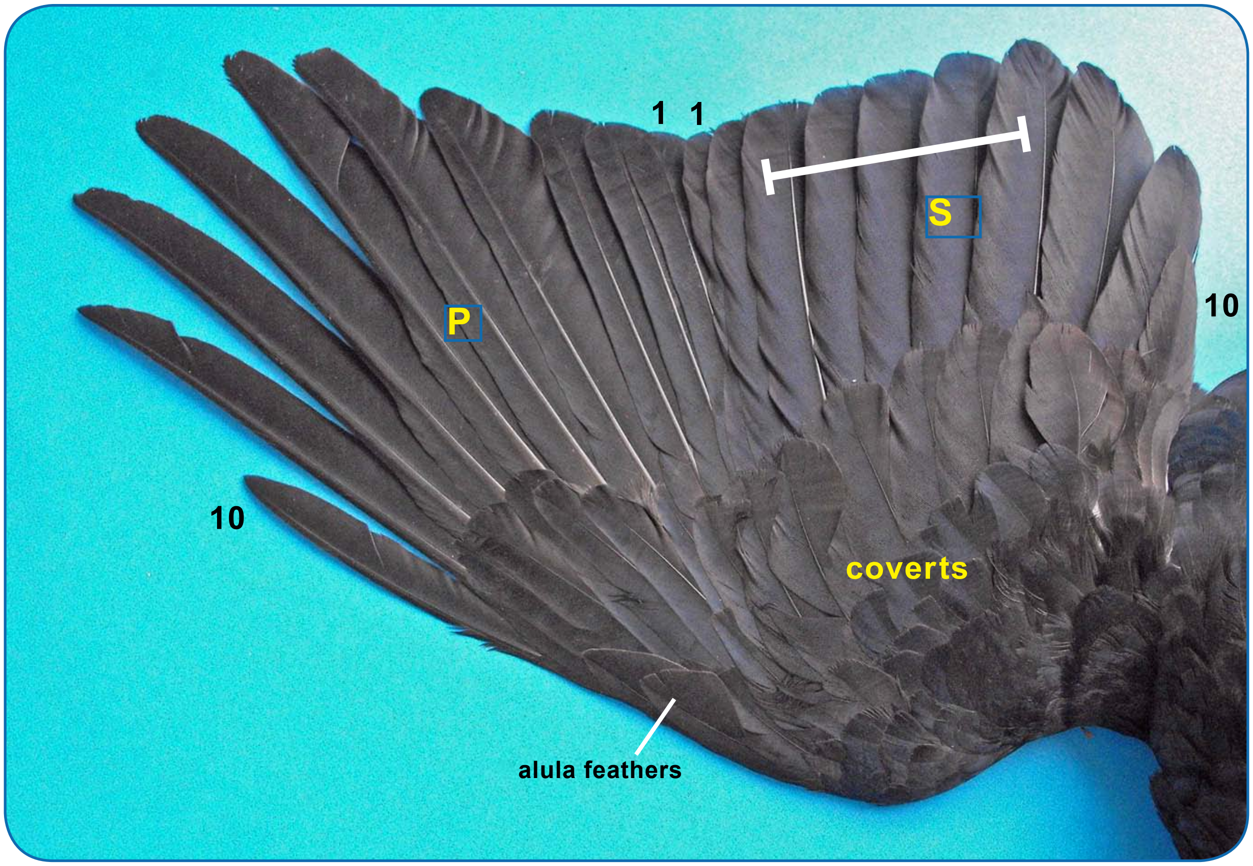
Rock Doves, *Columbia livia,* were captured to determine the relationship between preen oil, feather wear, and parasitic loads. Surprisingly, 1–3% of these birds in **Utah** and **Illinois** did not have a uropygial gland. One Rock Dove without a gland carried 275 lice. However, some doves with glands may harbour over 10,000 lice. Using caged birds, eight had their gland removed and seven intact birds were the control. The birds were caged and monitored over four months –

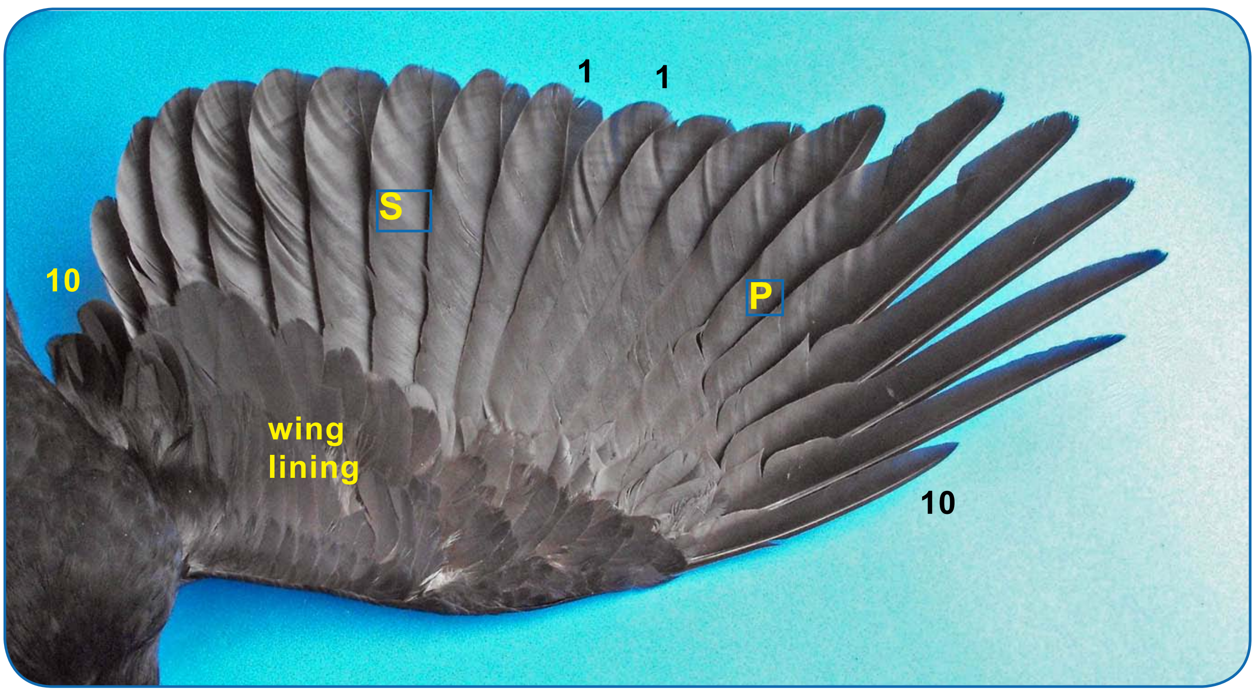
(1) without a gland, the feathers were in poorer condition, lacking the tiny interlocking barbules that give feathers their fluffy appearance
(2) stage of body molt did not appear to have an influence on feather quality



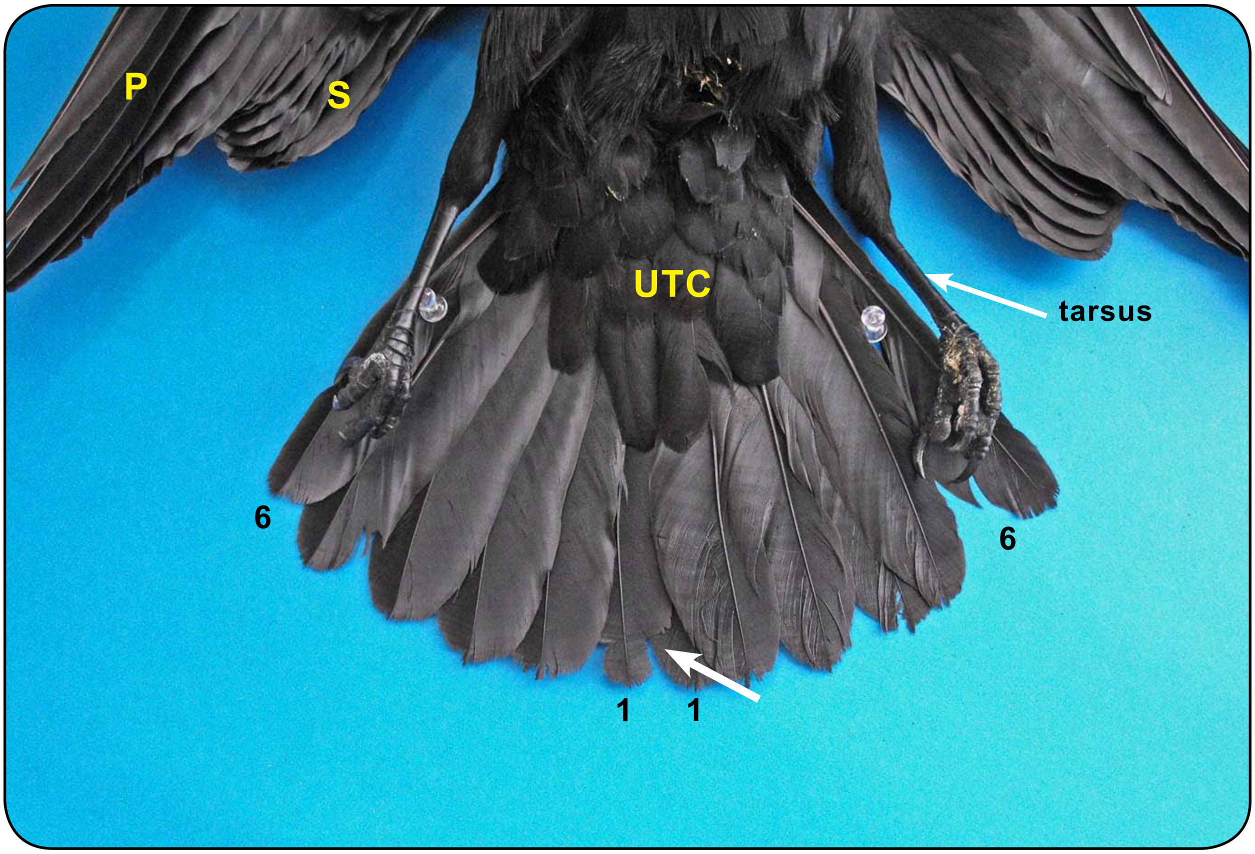
Flight feather magnified

Molted American Crow feather (*below* or *ventral*) collected on lawn near nest on 4 June 2011 in **Winnipeg**. Total length 20 cm; width 4 cm; calamus (quill) 3 cm long



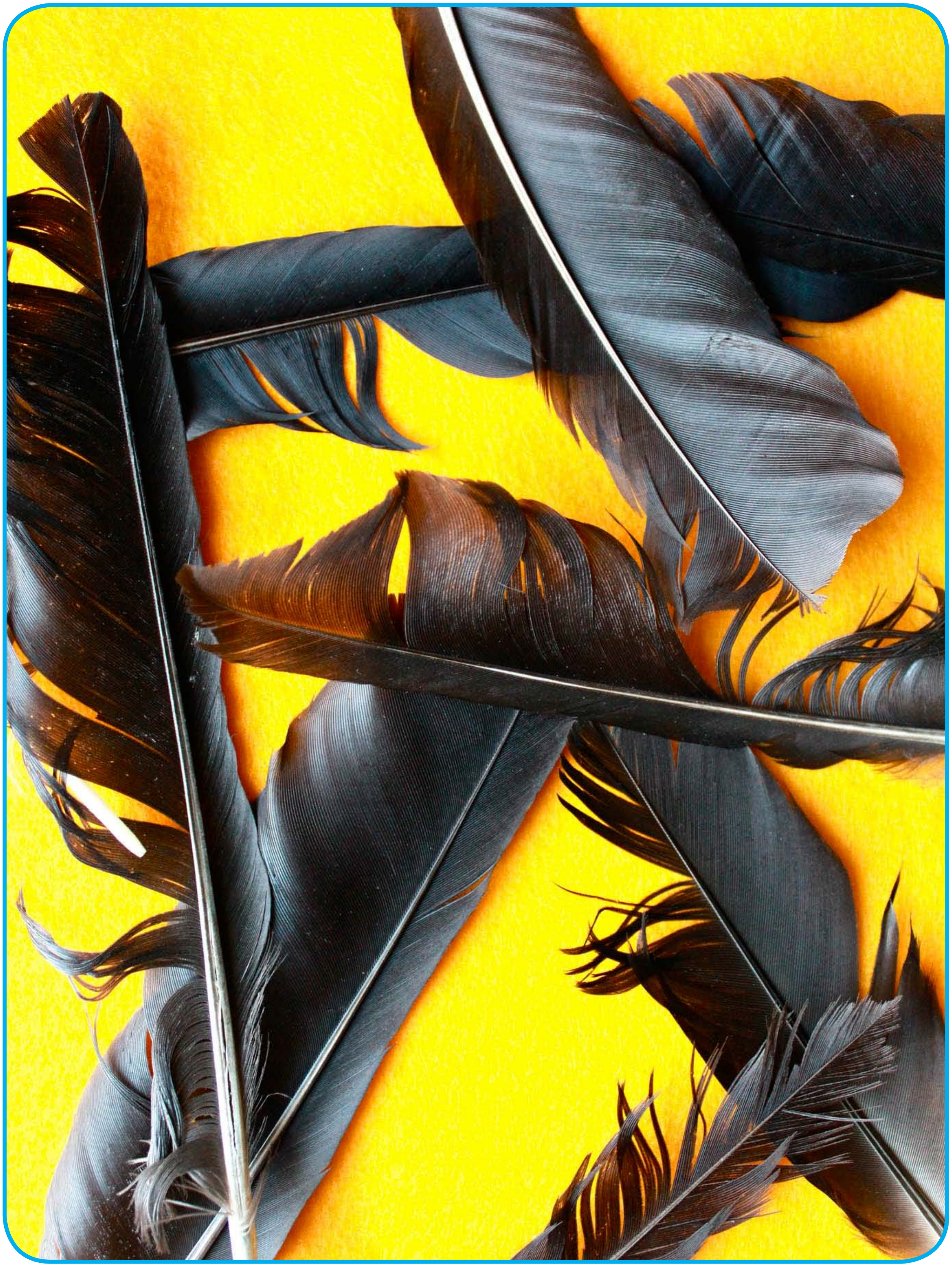


Top – notice a purplish sheen on the dorsal side of some central secondary feathers (**S** with bar); **bottom** – ventral surface of wing of a juvenile male American Crow (about 6 mos. old with a wing chord 30.5 cm long) found dead in Chatham, **Ontario**, 8 December 2011. **P**rimaries 1–10; **S**econdaries 1–10



12 tail feathers guide the crow in flight. The ragged rounded tips are indicative of a juvenile crow in its first winter (this one about 6 months old). The arrow points to a fault bar (notch) near the tip of a # 1 tail feather. The tail feathers will be molted and replaced in this male's second year of life, if it had lived. **UTC** = Under tail coverts, **P** = Primary wing feather, **S** = Secondary wing feathers

Upper tail coverts (**UTC**) of an American Crow; December 2011, Chatham **Ontario**, juvenile male

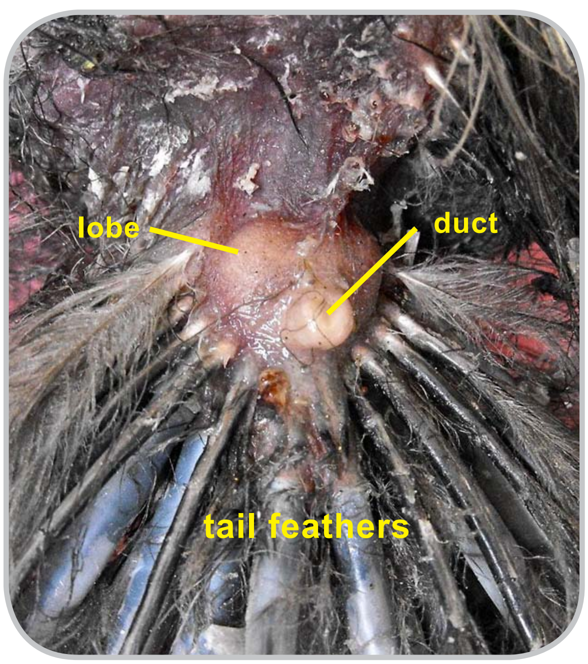


The molt

(3) rates of preening for captive birds, with and without a gland were similar – 20% of their time
(4) the load of feather lice was not affected by gland removal
(5) gland oil may help control bacteria and fungi that degrade feathers [65m]

Was there a relationship between the size of the uropygial gland, ectoparasites, and egg hatching success? From 212 birds in **Denmark**, the preen gland was removed and weighed. The larger the bird, the larger (mass) the uropygial gland. The order Mallophaga (chewing lice, biting lice) consists of 3 suborders – Ischnocera, Amblycera and Rhyncophthirina. All members possess functional mandibles. Birds with a relatively larger gland –

(1) had more genera of non-sucking lice of Amblycera, a large suborder of chewing lice that are parasitic on both birds and mammals. They roam over the surface of a bird and are not permanently attached. They feed by chewing soft skin and drinking blood
(2) had more feather mites



Uropygial gland (oil gland) of Tarsus on 11 June 2011 when she died. The 2 lobes together are 1 cm wide with the raised duct 3 mm wide; situated dorsally at base of tail feathers

(3) had fewer genera represented in the suborder Ischnocera, than in the above suborder Amblycera
(4) had a relatively large bursa of Fabricius
(5) had a higher rate of egg hatching success since, in theory, the gland appears to work against microorganisms in feathers which may lessen the contamination on eggs
(6) had lower levels of antibodies in nestlings compared to adult birds [38m]

Tarsus, with a wing chord of 16 cm when fledged, had a uropygial or preen gland 10 mm wide with the raised central naked duct (pink nipple) about 3 mm wide (photo this page).

Bacteria and fungi may be one of several reasons why birds molt their feathers. In **Ohio**, from 1993–1996, feather-degrading bacilli, chiefly *Bacillus licheniformis*, were cultured from feathers of wild birds. From 1,588 birds of 83 species, 7–11% harbored bacilli. Dorsal and ventral feathers, and the upper surface of the tail were sampled for bacteria. *B licheniformis* is gram positive and rod-shaped. It forms endospores and can degrade feathers, although white feathers are more susceptible than dark feathers. In the laboratory, white chicken feathers were degraded in 3–14 days.

Ground feeding and water birds had the highest prevalence of bacilli. Bacilli peaked over the cold months, November–February for the resident House Sparrow. Counts were lower in the warm season when feathers were being molted and perhaps had a drier environment for these vegetative bacteria. Although American Crows were not included in the survey, some of their habits are similar to those of the American Robin, which had a prevalence of 26% from a sample of 19 birds. Other researchers have found 13 species of keratinolytic fungi on plumages of birds [3b1]. Very little has been studied on the microorganisms of plumages. Consequently, we really don't know what effect they have on the lives of birds.

Adrenal gland

The adrenal gland functions during periods of stress for birds, as it does in mammals. The

glands are a cream to orangey color and lie beneath the testes and on the anterior lobes of the kidneys (**photo page 56**). Inactive male testes do not cover the adrenal glands, which are usually two distinct organs. When sectioned and stained with Zenkerformol solution, two types of tissues were revealed – chromaffin tissue and the interrenal tissue. The chromaffin tissue produces epinephrine (adrenaline) [h40].

From 143 species a few observations [h39] –

(1) The relative weight of adrenals in birds collected with an egg in the oviduct was not heavier than birds of the same species not ovulating

Ear opening (9 x 6 mm) of a juvenile, male American Crow from the Chatham roost in southern **Ontario**, December 2011

(2) In Myrtle Warblers collected in the spring and autumn, the adrenals and thyroids were similar in both seasons
(3) Parasitic loads may change the weight of adrenals and thyroids
(4) The relative size of adrenals and thyroids in various species was not related to the bird's activities

The body weights and organs from 3,690 animals were examined in the 1930s. For one male American Crow from **Ohio** [41c] –

Total weight 337 grams
Brain 9.3 g
Thyroid 0.4 g
Adrenal gland 0.8 g
Heart 3.2 g
Lung 10 grams

Anal glands

The anal glands in 72 species of birds from museums' collections were associated with thick squamous epithelium in the anal region. The secretory parts of the glands were simple or branched sacs, or tubules of secretory epithelial cells. The number and size of the anal glands were evenly distributed. One adult American Crow had no external anal glands and relatively small internal anal glands [q02]. The European Rook's anal glands were described as "tubular or bulbous and the gland cells as being mucus-producing" [g66].

The ear

Dr. John Godman in Rambles of a Naturalist # 11 (online)

This crow [which he shot], however, afforded me instructive employment and amusement, during the next day, in the dissection of its nerves and organs of sense; and I know not that I ever derived more pleasure from any anatomical examination, than I did from the dissection of its internal ear. The extent and convolutions of its semi-circular canals show how highly the sense of hearing is perfected in these creatures.

Sclerotic ring

The sclerotic ring is "composed of a number of individual plates, placed side by side and overlapped to form a bony ring which surrounds the pupil of the eye and extends inward to a distance that is exceeding variable in different orders of birds." From 235 species, 1,404 pairs of rings

A well-dressed juvenile American Crow

were examined in all but one order of birds in North America. A few of the 10 generalities were –

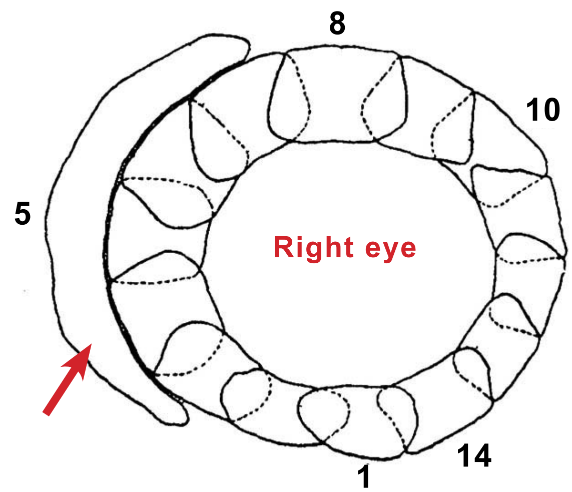
(1) A characteristic of the bird's eye is the sclerotic coat of small bony plates overlapping to form a bony ring
(2) The ring pattern is based on the number and position of over- and under-plates. The number ranges from 11 (order Columbiformes – doves and pigeons) to 18 (the Common Tern and American Wigeon), with 14 or 15 the most common
(3) The sclerotic ring protects the eyeball and supports it during contraction of the ciliary muscles, a ring of striated smooth muscle that controls accommodation for viewing objects near and far. As such, the muscles that accomplish this are not attached to the bony ring itself

The shape and thickness of the plates varied around each eye. Like the skull, each plate in the scerotic ring increased in size from those in nestlings to those in adults. In the family Corvidae, 9 species and 60 pairs of eye rings were examined. The number of thin bony plates was 13–15. An extra curved bony plate was **NOT** present in the genera *Corvus*, *Cyanocephalus*, *Nucifraga* and *Perisoreus*, but was present in the jays *Cyanocitta* and *Aphelocoma.* From 14 Magpies, 4 had a vestigial plate in one or both eyes. This structure may have some taxonomic value [57c].

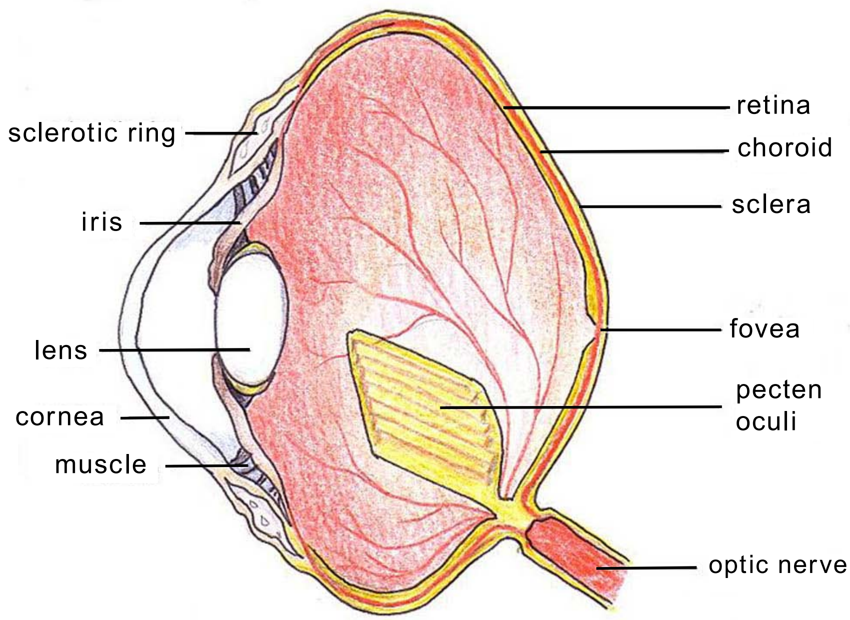
The eye

Braekevelt in the early 1990s described the microscopic structures within the eyes of light-adapted American Crows in Winnipeg **Manitoba**. Overall, a crow's eye appeared similar to that of other avian species. The structure of the retinal pigment epithelia (RPE) region was examined with light and electron microscopy. The RPE consisted of a single layer of cuboidal cells about 10 μm high and 12 μm wide. It interacted with photoreceptors in the maintenance of vision. The RPE cells had a single, rounded, centrally placed nucleus. Mitochondria were abundant towards the base of a cell and variously shaped. Myeloid bodies (function unclear) were common in RPE cells of the crow [58b].

The light-adapted photoreceptors of the American Crow were composed of rods (night vision), single cones (color vision), and double (unequal) cones present in the ratio of 4 to 3 to 3 respectively. The rods were stout and the outer segments reach to the RPE cell body. The single



511. Sclerotic ring composed of 14 plates in the Western Scrub-Jay, *Aphelocoma californica*, showing the accessory bony plate (arrow) extending from plates 3–7 along the temporal (temple) margin, Camera lucida [57c], © American Ornithologists' Union

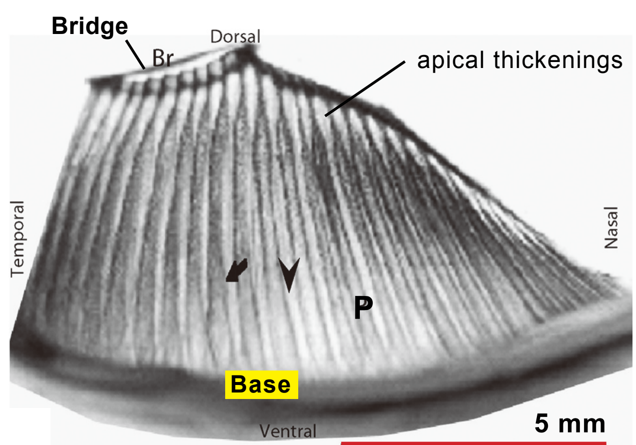


512. Lateral view of the avian eye of a bird in cross-section, © Original uploader was Jimfbleak at en.wikipedia; Art from wiki

cones (color) had a slightly tapered outer segment and a large heterogeneous oil droplet. The double cones were longer and stouter and had a more homogeneous oil droplet. The cone photoreceptors were tightly packed. Neither the rods nor cones appeared to have photomechanical movements in the crow. All were invaginated in flat synaptic sites [59b].

Pecten oculi

Next to be examined was the pecten oculi in the eye of the American Crow. The pecten, found only in birds, is an erectile projection into the gel-like vitreous of the ventral part of the avian eye cup. Of the 3 types of pecten, the pleated was the most common. In the American Crow, the pecten was very large and consisted of 22–25 pleated folds. A bridge of tissue held it in a fan-like shape that was widest at its attached base (**image right**). Numerous capillaries and melanocytes (pigments) occupied each fold. Presumably, one of the pecten's roles is to bring nutrients to the inner retina [57b]. This nutrient supposition was linked to its functional morphology, which correlated with the life-style of a bird and its functional needs [k39]. Braekevelt thought it may have evolved to increase the visual acuity of the retinal image in birds by shifting the



Pecten oculi – *lateral view*, occupies the inside of the eye cup of the Jungle Crow, *Corvus macrorhynchos*. **P** = pectinal pleats with alternating furrows (arrowhead). The base B is about 10 mm wide with 24 or 25 pleats and tapers to the apex of the heavily pigmented bridge (**Br**). The pleats are highly vascularized [r03], © Okajimas Folia Anatomica Japonica

blood vessels and mitochondria from the avian retina to the pecten [53b].

Pecten oculi were dissected from the eyes of dead Jungle Crows, *Corvus macrorhynchos*, (weight 840 g) in Japan. Their pecten was black or brown, with 24 or 25 pleats, and numerous specialized capillaries 20 µm or less in diameter. The pecten lay over the optic disc, and the free end (the bridge) extended into the vitreous. The melanosomes may provide protection against ultraviolet light [r03].

Gizzard

This organ follows the proventriculus and is the grinding instrument for the hard food (seeds) that a crow may swallow. The lower half is composed of finger-like projections with strong lateral muscle on the outside. The gizzard is somewhat larger than the heart. Ground food leaves the gizzard through the pylorus opening into the duodenum.

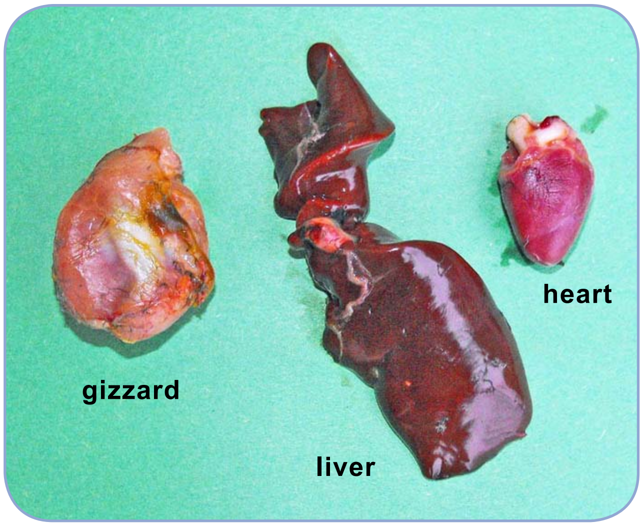
Gizzard (stomach) cut open top to bottom

Gizzard sliced open and contents removed. This male juvenile found dead had little food in its stomach

Heart

The avian heart is 4-chambered as is the human heart. "Relative to their size and mass birds have the largest and strongest hearts of all the vertebrates" [05p]. The left ventricular wall is more

American Crow in flight

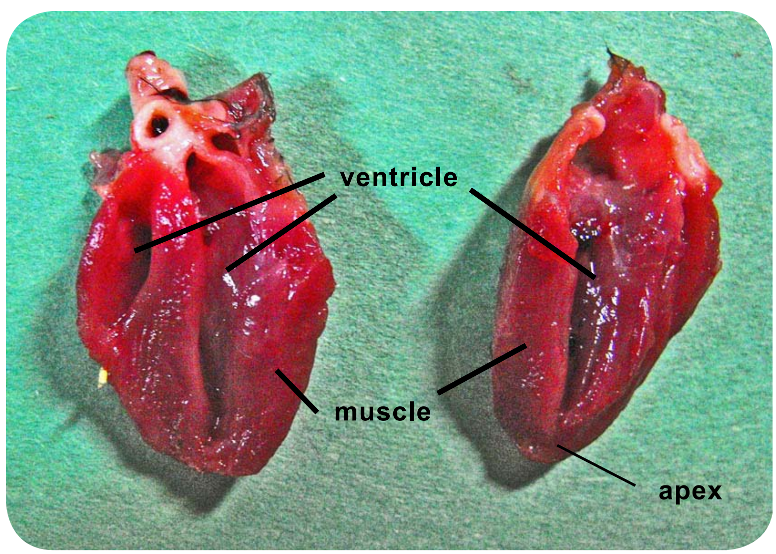


Comparative sizes of three internal organs of an American Crow. Gizzard (stomach), liver, and heart. A small portion of the liver was lost on removal

I let the soft East wind bathe my face.
Everywhere the Spring is blazing
With ten thousand shades of blue
And ten thousand colors of red.

– Chu His r47

muscular (thicker) than the wall of the right ventricle. The apex of the heart is the blunt narrow end. It is composed mainly of muscles of the left ventricle. Blood flows out of the right ventricle and through the pulmonary arteries to become oxygenated in the lungs. The pulmonary veins return the "red" oxygenated blood to the heart and into the left ventricle. The blood is then pumped into the body, including the two small coronary arteries that supply the heart with oxygen and nutrients. At rest a crow's heart rate is 345 beats per minute [earthlife.net/birds/blood.html]



Heart of an American Crow cut open to show ventricles and muscles. At rest, it purrs at 345 beats per minute or 6 / sec

An elegant American Crow